

# SCHOOL SCIENCE AND MATHEMATICS

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## ORIENTATION IN CONSERVATION

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The devastation of national resources and the huge wastage of materials occasioned by the war bring nearer the time when America must face the issue of living within her income of natural materials and energy.

Teachers of social studies and science carry a major part of the burden of developing in our growing citizens a sense of responsibility toward our natural resources and a sound scientific foundation for a national program of conservation.

With many of us the teaching of conservation tends to deteriorate into "busy work" which we carry on to meet the letter of current demands. We must not allow this to happen. We must instill the spirit of conservation almost as a religion. To keep ourselves inspired and in line with our goal we must occasionally look far up the row we are cultivating rather than give all our attention to the plants at our feet. The authors have here put down in outline form their own recent thoughts on conservation in the hope that they may stimulate thought and reorientation on the part of other classroom teachers.

- I. *Our ultimate goal*: That civilized man come to live in equilibrium with his environment.
- A. *Definition of goal*: To exist on the earth indefinitely the human race must be assured of:
  1. An adequate supply of food.
    - a. Food crops must be grown without impoverishing the soil or subjecting it to avoidable erosion.

- b. Food animals must be produced without deterioration of their pasturage or the land that produces their food.
    2. Materials for protection, construction, and communication.
      - a. Fibers directly or indirectly from the soil.
      - b. Paper and wood from forests at the forests' rate of growth.
      - c. Metals from mines without avoidable waste and from other sources (such as clay and the sea) as far as possible.
      - d. New materials such as plastics and insulating materials as far as possible from inexhaustible or self-replenishing supplies.
    3. Adequate supplies of energy.
      - a. Conserve present stores of mineral fuels and utilize annually replaceable wood, straw, etc.
      - b. Develop water power.
      - c. Discover and develop new methods of tapping the sun's energy stream.
    4. Scientific management of wastes of living and of industry so that contamination of the environment is avoided and by-products are utilized.
    5. Control or favorable balance among organisms with which man is interrelated.
      - a. Predators vs. herbivores.
      - b. Herbivorous insects vs. their parasites.
      - c. Human parasites: germs and their carriers, parasitic worms, parasitic insects, etc.
  - B. The place of this goal in our national thinking.
    1. It must direct the actions of those who have outstanding responsibility in national affairs—leaders in business enterprises, government executives, legislators.
    2. It must direct the attitudes and actions of the rank and file—stockholders and voters.
    3. All who should be influenced are passing through our classrooms.
- II. The more immediate goals of conservation teaching:
- A. Knowledge of the scientific facts and principles on which conservation must rest.

1. Man's absolute dependence on soil, plant life, animal life, sun's energy, fuels, minerals.
  2. Facts of ecological succession and the importance of attaining a balanced condition in which materials are used only as fast as they become available.
  3. Facts of interrelations between plants and animals which affect man: herbivores versus plants; predators versus carnivores; insects versus parasites, germs and their carriers, etc.
- B. Knowledge of the destruction and waste which are going on.
1. Loss and deterioration of soil.
  2. Shrinkage of forests.
  3. Destruction of wild plant and animal life through unwise management.
  4. Wastage and extravagance in fuels and metals with prospects of their exhaustion.
- C. Knowledge of some modes of action which will reduce deterioration and waste.
1. Ways of preventing waste of exhaustible metals, fuels, etc.
  2. Ways of preventing deterioration of self-replenishing sources such as soil, forests, animal life.
  3. Use of materials from practically inexhaustible sources such as magnesium from sea water, aluminum from clay, energy from sunlight.
- D. Knowledge that new modes of action are needed and can be invented or discovered—development of protein food from soy beans, and yeast, challenge of possible direct capture of energy from sunlight, of new methods of managing soil.
- E. Development of conservation spirit.
1. A continuing interest in the problem.
  2. Willingness to forego immediate personal gain for the future public good.
  3. Willingness to act whenever "conservation action" is appropriate.
    - a. Voting and expressing opinion to legislators.
    - b. Caring for our property, farms, farming machinery, forests, etc.
    - c. Conserving fuel, food, metals, etc., in personal, corporation, or public use.

## III. A Plan for Conservation Education.

1. Start early. (With the great grandparents—or at least with the babe in arms.)
2. Have an over-all view. Hint to elementary teachers—lay foundation in minds of boys and girls upon which later teachers can build.
3. Present related ideas in many appropriate connections, remembering that the conservation attitude like all true education, is caught, not taught.

There are units of study in science, social science, health education, home economics, etc., in which the teachers should constantly have the conservation goal in mind. The following are only a few of such units that can be made to contribute to the conservation idea.

- a. Soils.
- b. Foods.
- c. Fuels.
- d. Harnessing energy.
- e. Agriculture in society.
- f. Government responsibilities.
  - (1) Health.
  - (2) Management of resources.
    - (a) Marginal land.
    - (b) Reforestation.
    - (c) Use of oil reserves.
4. Make sure that the "argument" is clinched, that the teaching is carried to a conclusion, possibly in the form of a unit on conservation in science or social science in the later high school or junior college years.
5. Use every appropriate method and device. There are no equally effective substitutes for:
  - a. Really adequate first hand observation in developing a sense of reality of the phenomena involved. For example, the universality of the erosion of soil and rocks.
  - b. Moving pictures such as: *The River*, and *The Plow that Broke the Plains*.
  - c. Reading for broadening experiences
    - (1) Texts.
    - (2) Articles in magazines such as those that tell what is being done in contour farming, forest management, range management.

- (3) Government and state pamphlets.
  - d. Guided and thoughtful expression for crystallizing learning.
    - (1) Oral discussion and talks by students.
    - (2) Written compositions.
    - (3) Conversation at home—Hint: when boys and girls “sell” the conservation idea at home they “sell” it to themselves.
  - e. Action for developing capacity to do.
    - (1) Food saving at home and at school (the clean plate campaign).
    - (2) School conservation projects on nearby farms.
    - (3) Reforestation of limited areas.
    - (4) Celebration of bird and arbor days.
    - (5) Planting of nuts and other seeds along highways.
    - (6) Originating neighborhood conservation projects and carrying them out.
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#### NEW FEATURES MARK 3rd EDITION OF “OUR ARMED FORCES”

Publication of a revised edition of “Our Armed Forces,” popular, illustrated book written especially as an introduction to the Army and Navy for high-school students, is announced by the U. S. Office of Education.

The new edition of this source-book for high-school boys and girls brings them up to date on most recent changes in regulations and the organization of the many branches of the armed services. Three new charts showing the organization of the Army Ground Forces, the Army Air Forces, and the Army Service Forces have been added, as well as illustrations of Army branch insignia for officers and noncoms, and Air Force badges.

Over 110,000 copies of “Our Armed Forces” have already been purchased. The book was written by the Army, Navy and U. S. Office of Education for student orientation. Recommended for publication by the National Policy Committee of the High-School Victory Corps, it is issued through the U. S. Infantry Association.

Information in the book will answer many questions students ask about the history, background, and traditions of the Army, Navy, Coast Guard and Marine Corps. It also suggests steps to take to prepare for the armed services. Other sections give detailed information on correct use of the flag, a glossary of service terms, and illustrations of insignia of military ranks and ratings. The WEFT Chart, a system for aircraft recognition, originally prepared by the Army Orientation Course, is included. Over 115 charts and photographs illustrate the text.

The 136-page “Our Armed Forces” can be ordered from the Infantry Journal, 1115 17th Street, N. W., Washington, D. C. Single copies are sold for 35 cents. In quantities of four or more, the price is 25 cents.

## EARTH SCIENCE DEMONSTRATIONS IN A GLASS-SIDED TROUGH

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A glass-sided trough makes possible several interesting and instructive experiments in earth science. The one shown in Figure 1 may be made easily and inexpensively.

The frame of the trough is constructed of 20-gauge or heavier galvanized iron which is cut and bent as shown in Figure 2. The corners are soldered together and braced with triangular pieces of the same metal. The outlets are made of short lengths of  $\frac{3}{8}$ -inch brass tubing soldered in holes cut in one end of the frame.

The frame is fastened to a base of  $\frac{3}{4}$ -inch plywood by means of nails driven through the bottom and covered with solder. The sides of the trough are made of  $\frac{1}{8}$ -inch or thicker window glass, or better, plate glass. They are held in place by a thin layer of modeling clay applied to the inside of the rim. This material forms a water-tight joint, and yet allows the glass sides to be removed easily if desired. If preferred, aquarium cement may be used to hold the sides in place. A suitable cement may be prepared according to the following recipe:

8 oz. dry whiting	Stir together dry.
1 oz. red lead	Then mix with raw linseed
1 oz. litharge	oil to the consistency of
	stiff putty.

### SOME DEMONSTRATIONS THAT MAY BE CARRIED OUT WITH THE TROUGH

#### *A Working Model of an Artesian Well:*

Figure 1 shows one way in which conditions necessary for an artesian well may be set up in the trough. Water, representing rain, is sprinkled on the catchment area. It soaks through the aquifer, and escapes from this layer through the "well," which consists of a piece of glass tubing pushed through the upper layer of clay.

Since the surface tension and viscosity of water are relatively great in a model as small as this, the water does not spurt out of the well, as is the case with some real artesian wells, but merely flows over the top. This flow, however, is quite rapid, and is made easily visible by small particles of sediment carried

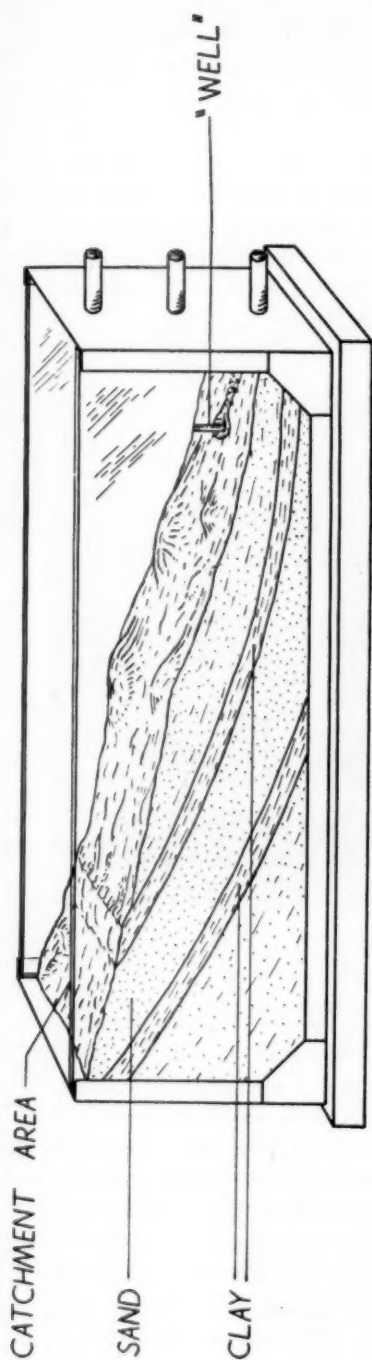


FIG. 1. Glass-sided trough containing a model artesian well.

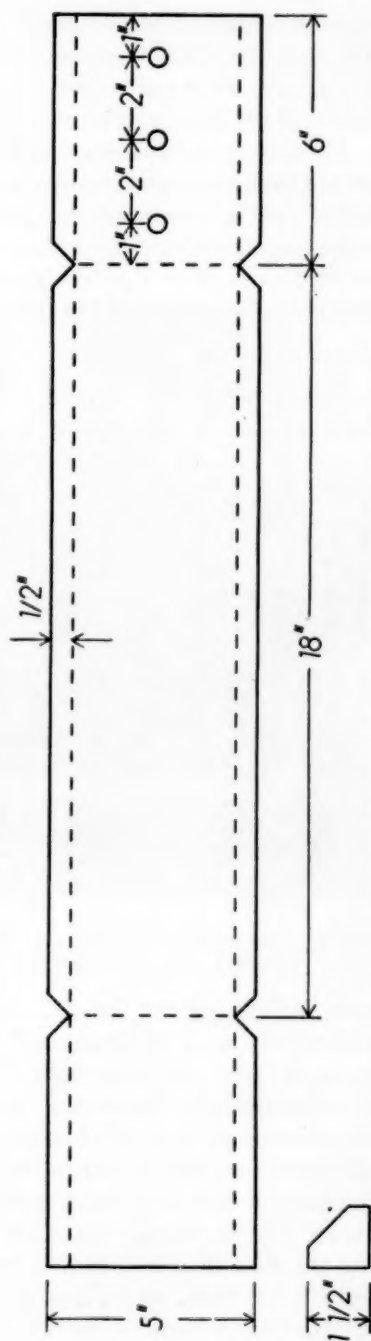


FIG. 2. Layout for the frame of the trough. The galvanized iron is bent at right angles along the dashed lines. A corner brace is shown at the left.

by the water. A longer piece of glass tubing, likewise pushed through the upper layer of clay, may be used to show the approximate height to which water would rise in an artesian well under these conditions.

If desired, set-ups may be arranged in the trough to demonstrate such things as the water table and its relation to ordinary wells, springs, swamps and ponds, a perched water table, an artesian spring, and a contact spring. By using a small amount of eosin or other dye to represent contamination, conditions bringing about the pollution of well water may be shown.

*Cross-section of a Delta:*

The internal structure of a delta may be clearly shown by building one in the trough, as illustrated in Figure 3. A metal

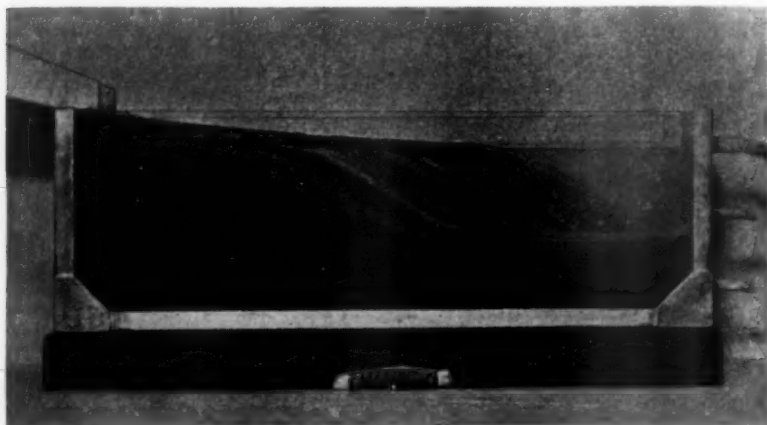


FIG. 3. Cross-section of a delta showing topset, foreset, and bottomset beds. The sediment was carried from the metal pan on the left.

pan, with a gap cut through one end, is supported with the gap over the edge of the trough. A "land" of sand and clay is built up in the pan, and is sprinkled with "rain." The water runs into a "lake" held in the trough, carrying with it sediment which it deposits as a "delta." Topset, foreset, and bottomset beds of the delta are clearly shown, as well as the relation between the fineness of the deposited material and its distance from the shore. The layers may be made even more pronounced by varying the flow of water from a trickle to a torrent, as is usual in nature. If sands and clays of different colors are present, the alternation of beds in the delta will be quite spectacular.

This demonstration is particularly effective in connection with another, that of building a miniature delta in a "lake" held in one end of a large water-tight pan, as shown in Figure 4. The sediment is carried by a "stream" from the "land" located in the other end of the pan. This demonstration gives a plan view of the formation of a delta. Observation of a miniature delta of this sort is superior in several respects to that of actual deltas. First, the action is far quicker than in the case of real deltas.



FIG. 4. Miniature delta formed in a large metal pan. The toothpicks indicate a former position of the edge of the delta. The larger sticks mark successive stages in the retreat of a miniature cap-rock waterfall caused by a resistant layer of clay.

Second, the entire delta is visible in one view, whereas actual deltas can usually be seen in their entirety only from the air. Finally, the under-water deposits, which constitute by far the greater part of a delta, are easily visible, while those of real deltas can seldom, if ever, be seen clearly. (How wrong is the concept of the Mississippi Delta obtained from maps which show only the portion above sea level!)

It is interesting to build deltas, in both the trough and the pan, in water whose level is rising or falling, and to note the effect on the structure in each case.

In this connection, it may be worth noting that remarkably realistic miniature deltas are often built in puddles during rain storms, and that it is worth while to take a class outdoors on a rainy day to observe these and other miniature geological features which are being formed.

The scientific study of deltas lends itself particularly well to laboratory experimentation. Two papers on this subject which may be valuable as reference material in high school classes are:

Nevin, C. M. and Trainer, D. W., Jr. (1927) *Laboratory study in delta-building*, Geological Society of America, Bulletin vol. 38, p. 451-458.

Smith, Arthur L. (1909) *Delta experiments*, American Geographical Society, Bulletin vol. 41, p. 729-742.

#### *Miniature Caverns and Sinks:*

An intensely interesting demonstration is to form widened joints, sinks and caverns on a miniature scale by allowing water to dissolve layers of "limestone." The "limestone" consists of hardened plaster of Paris. This material is slightly soluble in water, and serves admirably to give some concept of how Karst features are produced. Unfortunately, the writer knows of no way in which the dissolved plaster can be caused to be re-deposited in the form of miniature stalactites and stalagmites.

A layer of plaster, an inch or less in thickness, is poured into the trough. Before it is completely set, it is cut with a knife lengthwise and crosswise to form "joints." Then it is sprinkled with a small amount of finely powdered dry clay shaken through a small cloth bag. Another layer of plaster is poured, cut, and sprinkled with clay in the same fashion. In this way, layer after layer of plaster is added until the trough is nearly filled. The clay prevents complete coherence of the layers of plaster, and probably acts not too unlike the clayey material which in nature often separates layers of limestone along the bedding planes. The cutting of the "joints," of course, bears no resemblance to the method of their formation in real limestone, where they are thought to be formed more or less simultaneously in all the layers by crustal forces.

The beds of "limestone" are next covered with a thin layer of clayey soil, and are allowed to stand a day or two in order to set completely. Water is then sprinkled on the soil. At first very little water soaks through the plaster, and most of it escapes from the trough as a surface stream. In time, however, the

water which does seep downward enlarges slightly those joints and bedding planes along which it flows. This allows more water to escape through an underground route, causing the solution of the plaster to be accelerated. Once an underground route becomes established, the joints and bedding planes are widened quite rapidly, and after a day or so miniature caverns and sinks appear, as shown in Figure 5.

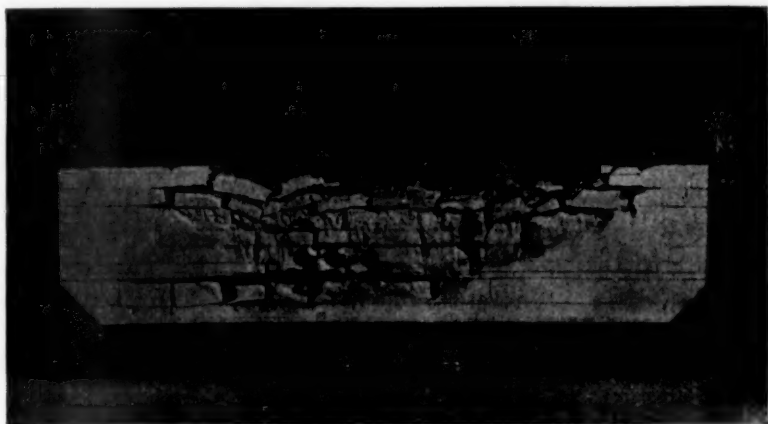


FIG. 5. Miniature caverns and sinks formed by solution of plaster of Paris. "Rain" fell from small holes in the bottom of the metal pan above the trough.

The water table in the trough may be adjusted by corking up various outlets. In this way it is possible to experiment with cavern formation under different conditions of ground water movement. Experiments of this sort might throw light on the current problem of whether limestone caverns are formed above or below the water table.

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#### WAUKEGAN IN THE NEWS

During the past five years, Waukegan's toll telephone traffic has soared to such a peak that the city now is the largest toll center in the Illinois Bell territory, outside Chicago. In 1938, it ranked 21st in the list of Illinois Bell toll centers.

The number of long distance calls has jumped from 571 to 6,900 a day. A few years ago about 40,500 calls were made daily in Waukegan. Today the number is more than 74,500.

This tremendous growth is directly due to the war. Waukegan is a large manufacturing center, and is near the largest naval training station in the world.

## THE PHILOSOPHY OF TECHNICAL EDUCATION\*

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What is Technical Education? Is it the soulless, godless, cultureless, dollar-marked Thing which some of our educators profess to fear? Or is it possible that there is some small virtue in it?

One leading educator pictures a truly educated person as one who can appreciate grand opera, the Old Masters of painting, sculpture, and architecture; one who can sit in his library and really enjoy the classics. His idea of education is that training which will make such appreciation possible. Our true technical educators fully agree with this definition.

But the grand opera must be housed, staged, and produced by highly skilled artisans and supported by thousands of others who are on the slow road to true culture. The final step in immortalizing the work of the sculptor must be done by the casting of the masterpiece in bronze. The Sistine Chapel had been built before Michael Angelo beautified its walls. And Leonardo da Vinci divided his fame between engineering and art. So the evidences of culture came after the production of wealth by skilled labor. Even the library of our educator was made possible by the technical skills of the printer, the architect, the builder—and perhaps would not be possible without the endowment of funds tainted with the profits from technical education.

But again, what is Technical Education? One day last spring, a young man entered my office with a greeting, an outstretched hand, and a boyish smile. I said, "Hello, Sergeant," for he had three stripes and an Air Corps insignia on his sleeve. It developed that he was on furlough from ——— Field in Colorado and was calling on his old (and young) friends at the school. He had graduated from a technical course two years before.

"You know, Mr. ———," he said at last, "this school has gotten me into a lot of trouble."

I remarked that being in trouble was nothing new to him, but demanded an explanation.

"Well, you see, I have been an instructor at ——— Field, and they have been handing me cadets in bunches of thirty for intensive basic training. I have had to wash out about ten

\* Delivered at the Mathematics Section of the Central Association of Science and Mathematics Teachers, November 26, 1943.

out of every thirty because they don't know common and decimal fractions. The officers in charge would protest that they must have the men.

"But I had learned from you, Mr. ———, that in order to maintain standards no one could get credit for something he did not know. These cadets were to go out as pilots, navigators, or bombardiers. The lives of their crews might depend upon their knowledge and skill and the thoroughness with which they learned. So I told the officer that I could not O.K. my students until they knew the work."

Bill is a typical graduate of Cass Technical High School—in other words, he is our product. His viewpoint on education and training is a direct result of the applied philosophy of technical education. (Bill is now at West Point. Army appointment.)

Technical education was born in this country at about the turn of the century in order to supplement and partially replace the old apprentice system, especially in the metal trades. The World's Columbian Exposition in Chicago in 1893 had brought together the world's inventions and discoveries and had shown the possibilities of a new industrial age. The improved process of manufacture of steel . . . the development of transportation and communication . . . the increasing prosperity and buying power of the people . . . and the distribution of electric power—all contributed to the growth of manufacture in the United States, and particularly in the Middle West. The demand for skilled labor increased so rapidly that the apprentice system no longer filled the requirements.

Far-sighted educators began to establish technical and vocational schools in or near industrial centers. In 1909, Cass Technical High School was founded in Detroit. Our mathematics department has had wonderful opportunities for development. At the time of the founding of the school, we were ordered to parallel our mathematics courses with the mathematical needs of the industries of a growing manufacturing city. We were given a free hand in building those courses and were judged only by results. The only requirement was that our mathematics must be delivered as needed by the various technical curricula that were being developed as the industries of the community demanded them. At the same time, evening adult classes were bringing definite mathematical problems to us from the industries, and continuation groups were organized by the management of the factories.

And so our school tried to keep pace with the city's growth. The foundation courses of mathematics, physics, chemistry, metallurgy, drafting, English, etc., were interlocked with the shop courses in machine shop, wood shop, building, electrical shop, automobile shop, and later, shop courses in aeronautics, radio, refrigeration, and heating and ventilating. And as the refinements of manufactures increased, so the underlying formulas became more complicated and the demands upon mathematical training became greater.

Our school was organized at just about the time of the change to mass production of the automobile. The Cadillac was still built by hand, the individual parts being machined and fitted for each car. Interchangeable parts were still a dream. If a car broke down, it stayed in the shop until a new part could be machined to fit.

But a new idea was being born in the science of measurement. A Swedish gentleman by the name of Johanneson perfected a set of gage blocks which were marvels of accuracy. They made possible the checking of measuring instruments so that parts could be made uniform and checked without being fitted together. Then Henry Ford upset tradition by making thousands of Model T's per day on his assembly lines. Repair parts and replacement parts were in every hamlet. Interchangeable parts and mass production were here to stay. The rest of the automobile industry followed quickly, and other industries followed the lead. Soon visitors were allowed to see a plant in production where thousands of men were each doing one simple mechanical job involving no mathematics, English, or science whatever.

Then school experts jumped to the conclusion that education need not involve basic knowledge except for professional training. Mass production called for no thinking, just manual dexterity. That idea persists in the minds of the fraternity today as evidenced by the vocational counseling now practiced in many school systems. Our schools of education are responsible for the training of such counselors.

But behind the scenes a strange thing was developing. Out at Ford's, the twenty-odd thousand production workmen were backed by six thousand men called tool makers who were necessary to keep the machines of the twenty thousand going. Other thousands were working, designing new machines and manufacturing them. Inspectors measured the finished parts with gages of every description. These gages had to be checked with

master gages to insure uniformity and the gages of all kinds had to be replaced and kept in repair. The sheet metal had to be stamped out upon metal dies in giant presses. The metal itself had to be tested and checked by metallurgists. The electrical equipment and production machinery had to be under the charge of maintenance men and machine repair men. Tool crib and stock men had to know the requirements of each division. Foremen and shop superintendents had to be masters of all the trades in their divisions.

In other words, behind the production machines, behind the unskilled labor, rose rank after rank of levels of skill, each calling for particular educational levels in the basic fundamentals of mathematics, science, and English. Even those who were classed as production workers demanded training so as to be able to take their places as skilled workers.

We attempted to classify the levels of learning and to identify them with the demands of the various levels of employment, but we found such an interlocking maze of requirements as to make such a task almost impossible. We did find, however, that the lowest levels of skill required a mastery of common and decimal fractions, that the semi-skilled required the algebra of the handbook formulas including radicals, together with the geometric truths of the circle, the triangle, and simple triangulation. The highest skills made necessary the use of logarithms, exponential equations, decimal exponents, and the rest of the basic mathematics that we *used to* teach in our classical high schools.

All along the various levels of employment, the head and hand are working together. After all, mathematics is the science of measurement. Now a part made in Detroit might meet a St. Louis-made part in Chicago, and they must fit. The gages checking these parts must match within tolerances that have changed from the hopeful hundredth of the last century to the split ten-thousandth of an inch of the last decade.

The highest type of mechanical minds gravitated naturally toward engineering, but the great mass of what we call *C* mentalities furnished the skilled mechanics. These are the slow, accurate thinkers who can be trained to surprisingly high levels of usable science and mathematics. This type of technical students became what we came to define as the non-commissioned officers of industry. These are the backbone of our American technology.

And along with the refinements of manufacture came the demand for beauty in the finished product. Design, color, and interior finish of pleasure cars became sales points in a competitive market, and industrial designers had to consider beauty of form as well as efficiency of operation. Exterior finishes in quick-drying colors brought new problems to the chemist. In the field of graphic arts, the printer and commercial artist worked together to develop new types of advertising. Training in the fine arts as well as in the useful arts took its place in technical education, with such courses as commercial art, art printing, professional music, dress design, jewelry, and interior decoration.

The first world war gave us the stimulus in the fields of aeronautics, radio, transportation, communication, and chemistry. After it, we made great peacetime strides in all fields. Now we are again at war, and under a still greater stimulus. The demands upon the men behind the guns call for the same basic training that mass production developed, but that need is doubled and redoubled.

If history repeats itself, the end of this war should find us poised for flight into a scientific era beyond our greatest effort at scholastic preparation. The youth of this country face today the greatest opportunity ever offered. Their success depends upon their basic training in science and mathematics. Radar, television, air transportation, plastics, diet, drugs, safety, and hundreds of other fields beckon them. These depend upon the same basic formulas of physics, chemistry, and the allied sciences.

Without realizing it, throughout the years we developed our Philosophy of Technical Education. It is a little hard to define, perhaps, but it is founded upon that long-forgotten word—Service. Of course, our boys and girls are not usually thinking of the high ideals of service. They are nearer to it now on account of the emotion of patriotism. But usually they are thinking of doing something that is fun, something that has the elements of an interesting puzzle. They are delighted to find that education makes sense, that the formulas of their mathematics class contain the same  $E$ ,  $I$ , and  $R$  that are in their electrical shop and in their physics class. They find that the educational pieces fit together and have an intimate connection with life. Back of it all is the joy of increasing power, the building of an understanding of the world about them.

So I would say that the Philosophy of Technical Education is based upon adding to the hand skills of the various shops and laboratories the knowledge of science and mathematics which connect them with their real meaning in life; that enjoyment of a life's work depends upon an understanding of the importance and a full use of all the skills attained in training.

Technical education has come into its own under wartime demands. When the Army induction chief tells us that (in mathematics) we rank at the top of the high schools of the state; when the corresponding officer in Navy induction says that in all-around preparation we are in his opinion the best in the country; when the industries of the community give our graduates preference in good times or bad; and when engineering colleges tell us that our graduates are among their best students and give them advanced credit—would it not be advisable for other schools to study our methods and our philosophy? Let us compare our philosophies and methods.

Our philosophy demands that success shall be measured by mastery of skills, that occasional failure in school is better than failure in life, that training in citizenship is possible only when the trainee becomes a useful citizen.

While we were pursuing our busy way, satisfied with our philosophy, a new philosophy of education was being developed in the classrooms of our teachers' colleges and being applied in our school systems. Our first intimation of it came when we sensed that our entering pupils seemed to expect to be promoted regardless of work done or levels of skill attained. They were continually protesting that they should be graded upon effort rather than upon actual results. We discovered that a grade of *A* brought to us from their junior high schools might mean a high rating in a high-intelligence group, a high rating in a medium group, or a high rating in a low mentality group. An *E* in a high group might mean greater skill in fundamentals than an *A* in a low group. It was all very confusing, especially as we had to determine pupils' real levels of skill before we could enroll them in technical courses where they could do the work required. We found it necessary to convince them that technical education meant study, even home study, and that failure was not only possible but inevitable for those who refused to work.

We studied the new system and were assured that it meant the millennium in education. No more would Johnnie be dis-

couraged by failure and be infected by a complex. He would be passed according to his mental rating and would be allowed to do the things he enjoyed rather than such disagreeable things as English grammar and number combinations. Work was to be the voluntary result of inspired teaching, motivation, activation (or is that a charcoal gum radio term?). Home study was "out." So was drill work. Of course Johnnie would not discover this. It was an educational secret. The parents were told in Parent-Teacher meetings that their help was not necessary or wanted in the preparation of lessons and that they could forget Johnnie as far as school was concerned. The new system would see that Johnnie was properly educated without home work and without worry to the parents.

Did the schools inform the parents that their children might be passing at a low level or that Johnnie was really of medium rank in a subnormal group? *They did not.* Johnnie came home with a passing grade in all subjects, and all was peaceful. Of course, when Johnnie wrote a "thank-you" letter to his Uncle Frank after Christmas, Mother wondered about spelling, capital letters, commas, periods, and paragraphing. She tried to remember her own letter-writing at the same age. But, after all, the lack of responsibility was very soothing, and she hoped for the best. When sent to the store, the children seemed to be unable to figure the cost of groceries and the change; so she ordered by telephone.

There was a slight disturbance when the children reached high school age and were placed either in a general or college preparatory course. The parents were not told that the general course would not admit the graduates to college, but the subjects were easy, and the boys and girls passed automatically. They dodged high school subjects like physics, chemistry, and mathematics and graduated without pain. Their diplomas really certified to several years of fairly regular attendance. The parents protested when they found that Johnnie could not go to college; but, after all, the responsibility of the community for his education was at an end. And Johnnie had no useful training to offer a possible employer except perhaps a football letter on his sweater. Part of the difficulty was Johnnie's being allowed to elect courses far short of his mental capacity. After graduation, he must join the ranks of unskilled workers or try to patch up his deficiency in evening classes if he hopes for success. It is from this class of disillusioned youth that come our zoot-suiters, loafers, and potential trouble-makers.

I sometimes wonder if our educational leaders ever studied real child psychology. There is an age-old war between teacher and pupil, the one trying to make the child work and the other trying to dodge work. This war has always been fought in all good faith and friendship with varying results, depending upon the wisdom and experience of the teacher. It has produced fairly good educational results in the past. But our educators, in their wisdom, have delivered the poor teachers into the hands of their ancient enemies by allowing promotion without work. And the poor boys and girls have won the battle but have lost the war. They are no longer the masters of even the elementary skills.

How does this philosophy affect technical education? Technical high schools have never been able to fill the demand for potential skilled workmen in industry. A quarter century ago, the general high schools were doing a fine job of training in the fundamentals of English, mathematics, and science. Their graduates were recruited by employers as needed. We still think that technical high school training produces the best skilled workers, but we are ready to admit that the most important part of our training is in the fundamentals and not in the shops. The shop training rounds out the picture for the student and makes the adjustment into the job come more quickly and easily.

But when our educational Master Minds founded the new philosophy of education, they gradually destroyed the value of the great group of pupils of medium mentality so necessary to our industrial life. Let us look at the picture: All pupils tested, pigeon-holed, labelled, and segregated as low, medium, or high; courses arranged according to mental ability; no levels of skill defined; automatic promotion. Johnnie could attain two-thirds of the skill set for a grade and pass to the next; thus handicapped, he would do perhaps one-half of the next semester's work and again be promoted. By the time he was promoted to junior high school, his skills in fundamentals were just not there.

Our leaders had never heard of the old wheeze about having to know more than a dog in order to teach him tricks. Johnnie was an old hand at dodging work. Did you ever try to "activate" or "motivate" your own boy into mowing the lawn? Johnnie soon discovered that he would be promoted regardless of work. His natural aversion to unnecessary effort caused him to slump from a high group to a medium group and then to a low group

in spite of "inspirational" teaching. We could no longer measure him by fundamental skills.

So our leaders changed the goals of education from definite skills which can be measured to an indefinite goal called Citizenship, of which no one knows the measure. Johnnie was taught in every class to get something for nothing, to live in a pretense of learning, to hit the high spots, and to be thoroughly superficial as a preliminary to taking his place in society. Then a course in "citizenship" taught him to be a good citizen. Often a boy or girl sees through the educational fraud and decides to learn more by not going to school; then there is another case of truancy and delinquency and we try to cure the evil by holding conferences and providing more play activities for them.

Thus our great reservoir of *C* mentalities gradually disappeared. Teachers protested against their handicaps of large classes, overloaded programs and rules against failing pupils. They were told by the educators and executives that any failures in their classes would be laid to poor teaching. A ruling in one school was that the only justified cause for failure was a minimum of 50% absence. A lot of good material was being wasted. We know because *we* were able to enroll them and salvage a good percentage of them. They would come to us with no skills, no habits of study, and a faint hope in technical studies. We would drill them in fundamentals disguised as shop problems, fail them if they deserved it, and they would come through with more or less success. We failed to salvage the really stupid (very few) and the chronic "giver-uppers" (very many). For years we have maintained a class for pupils who had been declared incapable of learning arithmetic and have consistently brought them from a fourth grade level to a ninth grade level of skill in the fundamentals of numbers. Many achieve this in one semester and some require two semesters. The method? Old fashioned drill work at the blackboard in addition, subtraction, multiplication and division of integers and common and decimal fractions.

In the meantime, we were trying to uphold our standards. Our failure list was a long one. We were given a group of entering pupils each semester with uniform passing grades in mathematics. Their skills varied from zero to medium in the things which we thought we should expect from pupils of *C* to *A* intelligence ratings. In educational meetings, our problems were given polite attention, and then we were told that our objectives

were different. We were called into conferences to discuss our high percentage of failures. We could prove disagreeable facts about inadequate preparation, and so we were left alone—very much alone. But the classroom teachers of mathematics in other schools told us privately that they could not teach general courses in mathematics adequately as long as the rules of the game allowed the pupils to be promoted and graduated without work. These pupils had come to include boys and girls of all grades of mentality from *E* to *A*. And so the skills in fundamentals have well-nigh vanished.

Now World War II has given us the opportunity to evaluate our education. Admiral Nimitz threw a bomb into our midst with his letter, and others followed, saying bitter truths about lack of preparation for the new trade of war. Reform was ordered, and our leaders became very busy—furnishing alibis and covering up the errors. The first cry was, "We gave the public what they demanded." Had they forgotten the selling of the New Education through the press and through Parent-Teachers' organizations a few years ago? The next reason was that pupils of low mentality were going through high school under compulsory education laws. Does that mean that the eighty per cent of high school graduates inadequately prepared in fundamentals are all subnormal?

Then came the flood of "refresher" courses for high school seniors. But what was there to refresh? Ask the teachers of such courses. Of course we must repair the damage as far as possible in the short time before their Uncle Sam calls them. But why not face the facts that such courses as physics, meteorology, and navigation must follow a knowledge of common and decimal fractions? Why not confess that the reform must start soon after the kindergarten in order to face both a war and a postwar demand?

I am afraid that we are a nation of braggarts. Right now we point with pride to the achievements of our young men in battle. We have every right to be proud of them. But do not forget Guam and Wake and the Philippines and our unpreparedness at Pearl Harbor in both training and material. I wonder how many of our fine young men have been and will be sacrificed because of our too-easy philosophy of education. We are still a long way from being perfect.

Right now, a postwar danger is showing itself. We are hearing of three-year courses in engineering being completed in five

months in military training centers. If a subject like physics can be completed in twenty weeks of eight hours per week, recitation and laboratory, then it can be completed in twenty days of eight hours per day. The hours add up the same. Our experts will greet this discovery with cries of joy. With the lessons of war training before us, our curriculum builders will have present high school subjects completed at the age of twelve, A.B.'s at fifteen, and Ph.D.'s at eighteen. Then give them the vote, and the picture will be complete. I have talked with many of the civilian instructors of these high-pressure courses in training centers, and they tell me that only a few of the trainees are able to get more than a superficial knowledge of the subjects taught. So perhaps our future Ph.D.'s will be just continuing their general high school education.

Now, the teachers of technical education invite you to join them in a crusade for service education. Let us try to bring all of our pupils up to the highest levels of fundamental skills of which they are capable. Let us forget the evil days of the depression when the usability of education was in question. Let us prepare for a peace which will demand the trained services of all our students. Let us try to define our levels of learning and skill and give credit for those attainments.

We will not even demand that our leaders confess their blunders if they will make an honest effort to correct them. In our fight against illiteracy, we must see that our high school graduates are not almost illiterate. When we rebuild from the foundations, perhaps we can regain the mastery of fundamentals of which we were once so proud. Then let us make refresher courses the rule not for an emergency but as part of our necessary training. We need to study the psychology of "forgettory" as well as the psychology of memory. A constant meaningful use of fundamental skills will insure their permanency.

Let us emphasize accuracy as never before and keep informed of the refinements in measurements in industry and scientific investigation. Above all, let us supplement inspiration with perspiration. If the word *drill* is still distasteful to us, let us invent a new word for our already bulging educational vocabulary and call it *repetitive thinking*. But let us use it again with great freedom.

Let us work at a system of scientific retardation and acceleration that will coincide with the attainments of skill in fundamentals. If our youth are given a goal of 100% accuracy, they

will again take pride in achievement. If Johnnie cannot add apples this semester, let him add peaches next semester before starting subtraction. Do not give credit for levels not attained.

Now I have laid the blame upon educators and educational leaders. They are the natural scapegoats. Perhaps I should have used the term *pseudo-educator* that I often use in thinking of particular individuals. We all know that some perfectly good ideas have been ruined by overzealous disciples and executives. But no one has come out openly to correct these shallow thinkers. If some leading educator would raise a banner inscribed, "Correct Our Mistakes," he would get the immediate support of industry, the final support of the parents, and a hearty AMEN from the classroom teachers. It is about time for someone to risk his job for what we all know to be right.

#### OUR OWN GALAXY

We live in a much fatter and solidier galaxy of stars than previously supposed, Dr. Harlow Shapley, director of the Harvard College Observatory, announced here in delivering the 22d annual Sigma Xi lecture at the University of Chicago.

An enormous thickness of the Milky Way, the galaxy or "universe" of stars in which the sun and earth are located, is established definitely through a general revision of the distances of the globular star clusters which has just been completed at Harvard. No large alterations are found necessary in the diameters of the galaxies, but Dr. Shapley confirms his earlier evidence that our own wheel-shaped galaxy is surrounded by an extensive haze of stars that is approximately spherical in shape.

The overall thickness of the surrounding star haze is found by Dr. Shapley to exceed 100,000 light years, that is, it would take light 100,000 years to cross the galaxy, traveling at its speed of 186,000 miles per second. This is 580,000,000,000,000,000 miles.

We are still located about 30,000 light years from the center of the Milky Way, as the distance calculations made possible by the new researches caused little revision.

"The original determination of distance and distribution of globular clusters led to the abandonment of the heliocentric hypothesis of the side-real universe since it pointed to the star clouds in Sagittarius as a region around which the globular clusters are aggregated," Dr. Shapley said. "That region was assumed to be the center also for all stars of the Milky Way. The clue given by clusters was later verified by studies of motions of stars around that center, again demonstrating that the sun and earth are in the outer part of the wheel.

"Cosmic dust and gas clouds between Milky Way stars have hindered our direct exploration of the home galaxy and especially prevented measurements of accurate distances for remote objects that are in low galactic latitudes, that is, near the Milky Way circle. But in higher latitudes far from the Milky Way band we escape much of the space-absorption and when more than 20 degrees from the galactic circle we can see through the dust. In those latitudes from 20 degrees to the poles at 90 degrees on both sides of Milky Way, we can now safely measure positions of globular clusters in space.

## "GROW" FOODS OR ONLY "GO" FOODS, ACCORDING TO THE SOIL\*

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It may seem paradoxical that food should suddenly come to public and critical attention, when only recently we were plowing under surpluses of it. It is all the more disturbing to many when we have led ourselves to believe American agriculture one of the most efficient, and American economics of distribution by means of steel and rubber one of the most unique of our services. Our high standard of living, and the indulgences of our desires and appetites have made us connoisseurs of good food. We have been connoisseurs, particularly, of fine qualities of food products, and of the more delicate and artistic touches of foods on an international scope. Now that we are suddenly confronted with the problem of feeding from our own crops the large share of our population under arms at a reasonably high standard of food excellence, and of sharing generously with other nations according to our customs as hosts, the sudden food shortage is more than a passing disturbance. Even wheat bids fair to disappear as a surplus bogey. Food is now a problem of its provision and not one of plowing it under.

### DECLINING SOILS MOVE US SEAWARD IN OUR FOOD HABITS

That the soil and its *internal supplies of essential plant nutrients* should be involved in this sudden appearance of the problem of a food shortage may seem far-fetched. This internal situation of the soil has not been a change as an explosive disaster. It has been coming on gradually. Absorbed in reshuffling economic and social situations involving peoples and votes, the fertility of the soil as the foundation of agricultural production was being exported or lost to the rivers and the sea, without our notice or appreciation of it. Other nations have been brought much earlier to lower standards of living through shortages of fertility and food, because their soils have been depleted. Such nations have pushed larger shares of their peoples nearer to the sea, and now live more by means of seafood into which their soil fertility has gone. The increasing depletion of the soil makes the

\* Delivered at the Central Association of Science and Mathematics Teachers, Chicago, November 26, 1943.

nations eaters of seafood, not by choice but under compulsion. We ourselves are now concerned about two seas—possibly not wholly in terms of food from them but of food for men on them and across them.

Hidden away as many of us may heedlessly believe ourselves to be in the midst of our extensive continent, we have been content with its liberal stores of fertility; not so much of it in the soils of the East, but more in the deposits of glacial drifts as ground and well-mixed rock materials to provide plant nutrients generously in the central states; and then still more in the chernozems or the fertile black prairie soils along the shelter belt



Natural vegetation varies in kind and tonnage. Wild animals (buffalo) select it for nutritional value more than for bulk as the different prairie grasses across Kansas from the West (17 inches rainfall) to the East (37 inches rainfall) clearly indicate. The nutritional value depends on the soil as made by the rainfall more than on the rainfall directly. (According to Shantz)

where bisons once roamed but where now wheat and Hereford cattle thrive. We have had little occasion to believe that the soil and its capacity to provide mineral-rich "grow" foods rather than only the woody "go" foods are of profound significance in the present world war. We are coming, in an international way, to appreciate the truth of the Russian proverb which says "An empty stomach knows no laws."

FOODS GET THEIR "GROW" VALUES FROM THE SOIL AND THEIR "GO" VALUES FROM AIR, WATER, AND SUNSHINE

The soil is the ultimate foundation of all life. It supplies the basic dozen (possibly more) chemical elements that are the nutrients coming from there as ash. The soil contributes these to serve in our vegetation as the means of fabricating the carbon

TABLE 1. CHEMICAL ANALYSIS OF THE HUMAN BODY IN COMPARISON WITH THAT OF PLANTS AND OF SOILS

Origin or Source	Essential Elements	Human Body %	Vegetation % Dry Matter	Soil % Dry Matter
Air and Water	Oxygen	66.0	42.9	47.3
	Carbon	17.5	44.3	.19
	Hydrogen	10.2*	6.1*	.22*
	Nitrogen	2.4*	1.62*	—
		96.1%	94.92%	
Soil	Calcium	1.6*	.62*	0.3† 3.47*
	Phosphorus	.9*	.56*	0.0075 .12*
	Potassium	.4†	1.68†	0.03 2.46†
	Sodium	.3	.43	—
	Chlorine	.3	.22	.06
	Sulfur	.2	.37	.12
	Magnesium	.05	.38	2.24
	Iron	.004	.04	4.50
	Iodine	Trace	Trace	
	Fluorene		Trace	.10
	Silicon		0-3.00	27.74
	Manganese		Trace	.08
Body Com- pounds	Water	65	—	
	Protein	15	10	
	Carbohydrates	—	82	
	Fats	14	3	
	Salts	5	5	
	Other	1		

\* These are involved in the plant and animal struggles to find enough to meet the high concentrations needed.

† Amounts common as the more available forms in the soil in contrast to the total, most of which is but slowly available.

‡ This represents struggles by the animals to eliminate it.

and nitrogen of the air and the hydrogen and oxygen of rain-water into what we call plant growth. Using this vegetation as food, the animals and man fabricate these soil-given and air-borne nutrients into their particular body compounds of still greater complexities serving for the growth and energy of our own lives. The dozen chemical elements coming strictly from the soil are the construction units, the building stones of plants, animals, and man. Though, as minerals or ash they constitute only 5 per cent of the weight while the air-borne carbon, hydrogen, oxygen, and nitrogen, constitute 95 per cent of plant and animal bulk, nevertheless, the soil-given nutrients wield the hand of control in spite of our tendency to visualize the air-

contributed elements as more important because of the larger mass they represent.

Accordingly as the contribution of these dozen nutrient elements is made liberally or stintingly, so it is that the soil and our treatment of it determine whether our foods are truly "grow" foods of service in healthful body construction, or whether they are only "go" goods with the more disappointing fuel values. It is the above-ground activity by plants that represents bulk and fuel values of our foods. It is the soil-fertility-providing activities of the internal chemical reactions of the soil coupled with the energy collection through sunshine above-ground that make our foods truly "grow" foods for healthy body building. We must build ourselves "from the ground up" in the fullest sense of the word.

VARIABLE SUPPLIES, AND SHORTAGES, OF NUTRIENTS  
IN THE SOIL MODIFY THE PLANT FLORA AND THE  
QUALITY OF EACH SPECIES IN IT

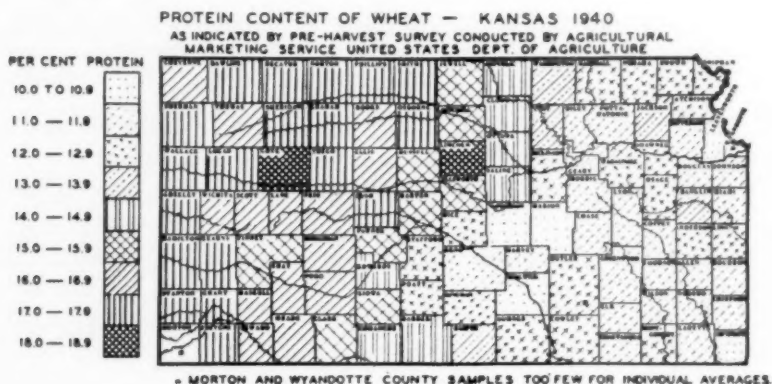
When the responsibility of contributing these dozen elements depends on the soil, and when these contributions represent only the very minutest amounts, we begin to realize that variabilities in the supplies and deficits of the different elements may occur in the soil. It is because of these variabilities and omissions in the soil's offerings of fertility that different kinds of crops occur on different soils. Plants, whether natural, domesticated or otherwise, are different in kind and quality as we go from place to place. We have been prone to believe that the weather, namely rainfall and temperature, determine whether a certain plant grows in one place or another. We have scarcely believed that the plants, like ourselves, are much more responsive to what foods they get, than to how warm or how wet they are.

Plants are widely different in their chemical composition. These differences occur according to the differences in what the soil offers in nutrients from which the plant can construct itself. Plant species, then, reflect the fertility of the soil in their larger values either as "grow" foods under liberal fertility supplies, or mainly as "go" goods of limited nutritional values under limited fertility given by the soil.

It is true that climate is the force that makes the soil by acting upon the rock. But this does not mean that the same climate always makes a soil with the same fertility content. Differences in the original rocks worked upon by climate also help to make

different soils. Prairie soils are made under lesser rainfall. They are soils that are less leached of their lime, or calcium, and of the whole list of plant nutrients among which calcium is the most prominent. Forest soils are produced under higher rainfall and warmer climate that deplete the soils of much that is still left in what we call the prairie soils.

We have mistaken cause and effect in relating the soils to the crops. The prairie grasses do not make the particular prairie soils, nor do forest trees make forest soils. Rather, it is the particular fertility level within the soils that determines whether mineral-rich proteinaceous prairie grasses will grow to support the bison formerly and the Herefords lately, or whether only the forest trees with their few turkeys the Pilgrim Fathers found in New England and the carbonaceous or cellulosic sugar-



Protein concentration of wheat decreases from western Kansas to eastern Kansas and reflects the difference in composition of a single crop according to the soil as was reflected by the original prairie vegetation. (USDA Crop Reporting Service)

cane and cotton crops of the South of today. Differences in the soil mean differences in the kind of crop and in the chemical composition as these crops fit into the fertility which the soil provides.

#### THE SOIL FERTILITY RATHER THAN THE PLANT'S PEDIGREE DETERMINES THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF THE CROP

As the fertility in any soil is ample or deficient so any single crop on it is different in its chemical composition, regardless of

the plant's pedigree. We have been prone to believe that the pedigree determines what the crop can do even to the fertility in the clay, or in the rock fragments, of the soil. Under this belief we have been paying our attention mainly to the crops. We have moved them from place to place and apparently believed that they will fulfill our desires regardless of the soil fertility differences. We are now beginning to realize that the soil and its chemical offerings are in control of the crop, and that the plant and its pedigree are no greater factors in plant growth than is the nourishment the soil gives.

Under the erroneous faith that plants are plants "for all that" and that plants are food "for all that," we have indulged in an extensive crop substituting or crop juggling. When alfalfa has failed we have believed that red clover could substitute. When red clover fails we substitute sweet clover. When this fails we go to soybeans and when they fail we go to lespedeza. This has been the series down which we have come with reference to the legumes, for example, in Missouri.

We have likewise been indulging in crop juggling with reference to the grains and the grasses. The tons of produce from plants have been taken as a measure of crop value instead of the nutrient offerings revealed by our inspection of the composition of the crop and therefore its real food value, as the significant measure. Our animals, their health and rates of reproduction have reflected this disposition on our part to look to the crop and to disregard the soil. We have been unable to grow our animals to greater maturity. We have been marketing them younger. We have been changing our breed types and searching for other breed types as the exhaustion of the fertility of our soil has been going on without our heed of it.

#### DIFFERENCES IN FERTILITY ARE REFLECTED IN ANIMAL AND HUMAN AILMENTS

Increasing animal "diseases" have likewise been telling us that the store of fertility in our soil is declining. New kinds of "diseases," for which the physiological bases are still unknown, are on the increase. Eye troubles, acetonomia, rickets, milk fever in cattle, and pregnancy diseases in sheep are illustrations of what has been coming into prominence as animal manifestations labelled "disease," when very probably such ought to be traced back to a deficient nutrition coming by way of declining soil fertility.

The figures dealing with our own draftee rejections in assembling men for the national service may help us understand this problem of the soil as a factor in making for better or for poorer foods, and consequently in making for better or for poorer health according to the soils concerned. When only three men out of ten are rejected in Colorado while seven out of ten are rejected in a southern state, according to a report by Mr. Rowntree, can we not look to our soils as they are less depleted in the lower rainfall of Colorado and more highly depleted of their nutrients in the South as having causal connection with this draftee situation? Is it not possible that we may be talking about "disease" and calling it a case needing "cure" when we ought to be talking about "malnutrition" and "starvation" as cases for their "prevention" through soil treatments?

We as higher animals, along with those lower in the scale, are finding ourselves pushed into this picture of soil fertility. Unfortunately, the picture is unfolding itself more in terms of *deficient* than of *efficient* living and health. Higher standards of living encourage more freedom in the choice of our foods. Choice of more sugars seems to be a freedom that is highly exercised, when in the United States we are correctly characterized as the "sugar eaters," since over a hundred pounds of sugar were consumed per person per annum in pre-rationing times. We have shoved up our "energy" foods or our "go" foods to an unbalanced proportion. To make matters more unbalanced, our soil fertility has been slipping away to reduce the "growth" values and the mineral values in many foods commonly credited with these services in nutrition. This shift in our thinking about ourselves has brought a similarly changed attitude toward our animals. They are compelled now to do more on roughage. Through crop juggling and declining soil fertility our roughage feeds have come to have fuel value mainly and too little of growth value. They too are mainly carbon consumers, when grown on deficient fertility of the soil.

#### NEWER KNOWLEDGE WILL SHIFT CONCERN ABOUT WEATHER TO CONCERN ABOUT SOIL FERTILITY

We have moved in this direction, namely going toward the fuel values and away from the growth values, because we have been thinking about farming the weather and the climate in place of thinking about farming the soil. We have been giving emphasis to moisture as the main criterion of crop production.

Too little is understood of the fundamentals in plant nutrition. The plant nutrients from the soil are not swept into the plant roots by the flow of water into them, as was once believed. Rather, the chemical pressures related to the concentrations of the nutrients on the clay portion of the soil determine the fertility movement into the crop roots. We have been prone to believe that large amounts of water mean large yields, and that large yields of plant bulk are an index of excellent production. We are now beginning to realize that it is not the water that determines the efficiency of the fertility of the soil, but rather the converse is true, namely, the soil fertility makes the water more efficient. It is the fertility difference that comes in as a cause when a 40-bushel crop of wheat can be grown in western



The soils of the United States provide mainly "grow" foods in the central states with lower rainfall but "go" foods in the eastern and southern states under higher rainfalls. (C. F. Marbut)

Kansas with 25 inches of rainfall, and yet 40 inches of rain will not even guarantee a 25-bushel crop of wheat in Missouri. The nutrients offered from within the soil more than only the water coming from above the soil are at the basis of our crop production, our animal production, and our human health.

The soil is made by climate. The crop yields are determined by the soil and its fertility in relation to the climate. Should we start with the rock itself, we can picture the view that the rock is changed into soil through processes of soil construction. These are constructive processes that make for more fertility and productivity in going eastward in the United States, for

example, from the desert as the annual rainfall increases to about 30 inches. In the pattern of the climate of the United States, the 97th meridian represents approximately the line of 30 inches of rainfall. As the rainfall goes above 30 inches, and as the temperature rises, the climatic forces bring on processes of soil destruction. East of the 97th meridian the higher rainfalls and temperatures represent soil destruction. West of this line the rainfall represents soil construction. It is east of this line that we find our forest soils. It is west of this line under the influences of lower rainfall—and to some distance east of the line where there is higher evaporation as in part of the cornbelt—that we find our prairie soils.

The prairie regions amongst the forests in Alabama and Mississippi, and again in Texas seem to be misplaced, according to this reasoning. Prairie soils of the black soil belt in Alabama are there because of the high lime content of the soils even though this is in a high rainfall region. The high lime content was retained because of the high lime in the materials originally serving as parent material of the soil. These lime-rich soils of Alabama and of Texas make prairie vegetation today in spite of the high rainfall and the forest vegetation surrounding it.

#### CROPS ARE "GROW" FOODS OR "GO" FOODS ACCORD- ING TO CLIMATIC SOIL GROUPS GROWING THEM

When we take the distribution of crops that grow naturally or readily across the United States we find particularly nutritious grasses and alfalfa as common crops in Kansas. We speak of the alfalfa crop as a "growth" food, and prescribe it for young animals and for production of milk, the natural food for growing animals. We find corn, one of the grasses, common in Iowa and Illinois, the two states on the eastern limit of our prairie soils. As we go south from these states, there is cotton, but this is on soils that were originally forests. In the tropics there is rubber, another forest crop where the rainfall is still higher and the heat more intense.

In this transition from the west to the southeast and across this array of crops, we pass through a definite series of chemical compositions of the crops at the same time. If the pattern of the chemical composition of the crops should be superimposed on the soil fertility pattern, the crops would reflect the soil's delivery of the nutrients according to the more recent concepts of this in relation to soil development in different climates. In

this transition across the states one goes from the "grow" foods of the West on the high soil fertility to the "go" foods of the Southeast and the low fertility of the soils.

#### SOIL TREATMENTS SERVE AS A SHIFT IN THE SOIL'S GEOGRAPHIC LOCATION

It does not follow, necessarily, that one must go far and wide to cover soil differences sufficient to bring this shift in nutritional values of the crop. Such shifts have been occurring in a single soil and in a single place in consequence of time, of intensive crop removal, and of neglect to return fertility to the soil. This shift has taken place most rapidly as the soils were initially less fertile in organic matter and in nutrient reserve minerals of the silt and sand fractions.

The rapid exhaustion of the calcium supply in our soils is familiar, as you remind yourself of the prevalence of red clover not so long ago where liming was later necessary to get this crop, and where today clover will not grow. The prevalence of the liming practice testifies that our cropping under disregard of the soil and its exhaustion is equivalent to moving our soils farther east into higher rainfall or the territory of the "go" foods, while liming is a partial attempt to hold them in, and push them westward toward the territory of the "grow" foods. Other nutrient elements, such as nitrogen and phosphorus, put into the soils are also helps by which the soil is magically pushed into regions of greater nutritive services to man and beast by way of more nutritious vegetation.

#### EXHAUSTED SOILS OF CENTRAL EUROPE VERSUS FERTILE SOILS OF OTHER COUNTRIES AS AN INTERNATIONAL PROBLEM

Our increasing and more intimate acquaintance with the Old World is bringing us to realize its exhausted soil condition and to appreciate our own fertility needs and supplies more thoroughly. Perhaps the present international disaster will take many of us away from home far enough to give us a more comprehensive view and a better perspective of our soils. That view, even after some extensive war period, will still carry a bigger welcome in post-war than any foreign soil view, as was true for the returning Yank soldier in 1918, who addressed the Statue of Liberty in these words, "I salute you, dear Lady, but if I ever do it again, you'll have to turn around." Perhaps in viewing

critically our post-war situation, the fertility of our soil will get its proper appreciation—prompted by rationing experiences at home as well as army deprivations abroad—to reshape our sense of values of it.

Soil conservation has just begun. Its evolution to date has brought it from building dams as cures to crop cover and proper soil management as prevention for running water and soil erosion. It is moving rapidly toward consideration of the internal condition of the soil, namely its fertility that grows the cover, encourages water infiltration, overcomes droughts, fills our wells and makes the lands bloom with foods for a healthy nation.



Human health goes with the soil and its fertility. Declining soil fertility reduces the "grow" foods and encourages "go" foods. (Scene from Wadesboro, N.C. Courtesy F.S.A. Photo by Post.)

You and I are probably going to be pushed much closer to the soil than will be done by our first "Victory Garden." We shall doubtlessly become better "Friends of the Land" in a deeper sense than one simply invoked by a backyard hobby. We shall soon realize that our soil fertility, like our scrap iron, has too long been exported. We need to begin now to cherish jealously the glaciated area of the central United States, and the "Midlands" of the United States or the belt of chernozem soils extending from Minnesota to Texas. We need to appreciate the

soil more, as well as to recognize erosion. Erosion has been hauling away the very body of the soil because we first extracted the fertility to weaken the body in its production of self-cover. That weakened soil body is reflecting itself now in weakened human bodies so that a "Town without a toothache" is startling news with headlines in place of a normal expectancy. Good health is such an anomaly that even the doctor doesn't know what his patient should be like when he finishes with him.

While we have moved to the "go" foods and speeded up our lives to burn them out in many ways, we have also burned out the fertility of our soil, that will be needed so much more in the near future. In rearranging the world's economic conditions, certainly the problem of food will not be considered as only a matter of tariffs, prices, and politics, but rather a matter of greater service in sustaining life that depends on the fertility of the soil. The map of the world can be properly remade only on the basis of its soil on which the nourishment and final contentment of peoples rest.

Certainly our national health picture as it is coming into clearer view from the data collected in assembling our armed forces will give us a clear conviction that our health is determined according to the soil. This view should likewise bring into focus the international picture as it rests on the different soils. We hope there will be some artistic mind on the final settlement committee which will correctly interpret what can be seen in terms of the fertility of the different soils. Regardless of the multiplicity of colors that may be involved, the picture should have but a single caption as a forceful reminder of what has been said in part before, namely, our national health, as well as "our national wealth, lies in our soils."

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#### PHYSICAL FITNESS PUBLICATIONS

Copies of U. S. Office of Education physical fitness publications may be purchased from the Superintendent of Documents, Washington 25, D. C., at the following prices:

- "Physical Fitness through Health Education for the Victory Corps"  
(Pamphlet number 3 in the Victory Corps series) 20 cents.
- "Handbook on Physical Fitness for Students in Colleges and Universities"  
25 cents.
- "Physical Fitness through Physical Education for the Victory Corps"  
(Pamphlet number 2 in the Victory Corps series) 25 cents.

## ASTRONOMY IN THE ELEMENTARY SCHOOL\*

JOHN STERNIG

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Of all the sciences, none has more appeal for children than astronomy. It has been my experience that children seem to have a universal interest in the heavens. They want to know about the things in the sky; what the moon, sun and stars are. They want to know about the planets and what they are like. They have an insatiable curiosity about the possibility of life on other planets and trips through space. In the past few years I have collected hundreds of questions on this subject from children of all ages. There is a remarkable consistency in the type of questions, which leads me to believe that astronomy offers something very basic, something most children want to know about. I do not know why this is so, for few parents or teachers do anything to actively stimulate the interest.

Perhaps it has its roots in the history of the race. Astronomy is one of the most ancient of the sciences. We are all aware of the fact that early man looked at the stars with curiosity long before he looked at the things of earth with anything more than practical interest in what they could do for him or to him. The earth sciences had to wait long ages after a study of the heavens began.

There is a mingling of reverence, wonder and a sort of fear which is still felt by all thoughtful humans who take the time to stand alone in the stillness of the night and look with unhurried contemplation at the stars. Something deep within us all responds to their call across the endless empty void of space, if we let it. Yet in these days of hurried living in cities with their towering buildings and bright lights shutting off the sky, how many of us ever think to raise our eyes up to the stars? It seems to me that men lost something most significant when their eyes and hearts became so glued to earthly things that they no longer saw the sky. It is a rare person who can call the stars by name or who knows the constellations and their positions in each season of the year.

But children still show interest and wish to know about these things. The way they listen when such things are talked about is an experience to bring a teacher joy. In the past it had too

\* Delivered before the Elementary Science section of the Central Association of Science and Mathematics Teachers, November 26.

often been assumed that children were not ready for astronomy before the junior high school. That is no longer true in all places, for many schools are aware of the vital interest which children have in this area and are doing something about it even in the lower grades. I feel that if we wait until junior high school with this, or any other science, we will be too late. That magic spark of curiosity is often gone if it has not been kindled into flame long before.

We talk about a science-centered world in which the things of science assume increasing importance. No one will deny that children need to be more science minded if they are to live in such a world intelligently; but we are still too often content to let their experiences come incidentally, which in many cases means accidentally or not at all.

Astronomy may be more poetic than practical in some respects, though the war has brought its contributions to navigation before the public. But poetic or practical, it is a treat to teach if properly presented. All I have ever needed to do is to get children's comments or questions started and the study was on its way. The rest is a matter of organization which offers grand opportunities for teacher-pupil planning. It ought never to be a teacher-planned unit of work based only on cut and dried facts gathered from books, with no consideration of the children's special needs and interests. Such an approach might easily kill an interest.

The same principles apply in this as in all teaching. I have used the following as guides for myself. 1. An experience should be well planned with the pupils. 2. It should provide for children's special needs and interests. 3. It should provide much activity where children can engage in more than mental exercise. 4. It should be dramatic. 5. It should be rich in content. I shall try to show how I attempt to follow these points in teaching astronomy.

First—planning. I sometimes start by leading a discussion on some observed phenomena; a bright meteor, a display of Northern Lights, some bright planets in the sky, or even the current phase of the moon. Any of these may offer a starting point. The group can usually be depended on to add comments and questions so that the whole field is opened up. Then the teacher as a member of the group can add things which offer other interesting possibilities. Many times I have found that such discussions start without any suggestion from me for

children are anxious to discuss things they have seen and wonder about.

Once the group has decided that they wish to know more about astronomy, our serious planning begins. Children feel a more personal interest in a study if they originate it and have a hand in deciding what is to be learned and how it is to be done. Together we work out a list of all the things they wish to know about astronomy. These things are then grouped under larger headings and those are arranged into sections in what seems to be the proper order. There is no substitute for this kind of teacher-pupil planning and it is a major source of unity and wholehearted cooperation in the group. The extra time it takes is well worth while in terms of concomitant learnings.

A typical outline of study which results from planning of this sort might be like the following:

- |                                     |                                       |
|-------------------------------------|---------------------------------------|
| 1. The Solar System                 | c. Nebulae.                           |
| a. The Sun, our star.               | d. Our Galactic Universe.             |
| b. The Planets and Plan-<br>etoids. | e. Other Universes.                   |
| c. The Earth, our home.             | f. Constellations.                    |
| d. Moons.                           | 3. Astronomical Tools                 |
| e. Comets.                          | a. Observatories.                     |
| f. Meteors.                         | b. Telescopes.                        |
| g. The Aurora.                      | c. Other Things Astron-<br>omers Use. |
| h. Where all these came<br>from.    | 4. What Use is Astronomy?             |
| 2. The Stellar System               | a. Navigation.                        |
| a. Space.                           | b. Time.                              |
| b. Stars.                           | c. Adding to Man's<br>Knowledge.      |

The precise organization will vary from group to group, but usually the contents will be quite complete if enough time is given to the planning. The list can then be checked against books on astronomy to insure completeness.

With these preliminaries out of the way we are ready to begin. I try to see that personal interests are cared for. One way of doing this is to get activities started at once. Individuals can then concentrate on their special interests without waiting for the class discussions to catch up with them. Group discussions are carried on along with the activities and we try to cover the entire outline in them. Books, teacher information, children's contributions, all are used.

The activity work is usually the thing that keeps interest high. It gives children an opportunity to use references and arts and crafts material. The following is a partial list of things which children have done during their activity periods in my classes.

1. Written projects on special areas of their own choosing.
2. Charts of the solar system, drawn or cut out of colored paper.
3. Solar system models.
4. Charts of the phases of the moon.
5. Phases of Venus and Mercury.
6. Charts and models of eclipses.
7. Earth-moon models.
8. Maps of the moon.
9. Models of the moon's surface.
10. Drawings and models of planets.
11. Drawings of imaginary trips through space and to planets.
12. Model rocket ships.
13. Drawings and diagrams of various types of telescopes.
14. Drawings of observatories.
15. Making experimental telescopes.
16. Charts to show distances to planets and time needed to reach them.
17. Handmade slides drawn on ground glass.
18. Star maps.

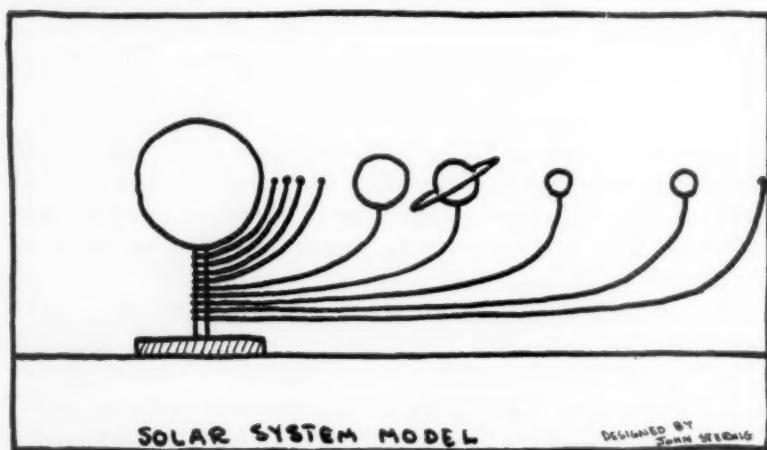
Space will not allow a detailed description of all these, but in most cases their nature is probably indicated by the title, and most astronomy books will offer the facts needed for their construction. The rest is up to the ingenuity and originality of pupils and teacher.

The construction of a solar system model has proved so popular in all my groups that I shall go into some detail on it. The models are made of wood, wire and a mixture of asbestos flour or fine paper pulp with wheat paste and water to make a clay-like substance. We first plan a scale in class and generally arrive at about the figures on the following page.

The sun and planets are made of the asbestos mixture. The planets are mounted on fairly stiff wires which have been curved around a grooved dowel rod so that they revolve freely around the sun which is mounted on top of the rod. The dowel rod is set in a wood base. When dry the planets and sun are painted

Name	Size	Distance from the Sun
Sun	3 inches (this is too small but would require a ten-inch globe to be correct)	
Mercury	$\frac{1}{8}$ in.	$\frac{3}{16}$ in.
Venus	$\frac{1}{8}$ in.	$\frac{5}{16}$ in.
Earth	$\frac{1}{8}$ in.	$\frac{7}{8}$ in.
Mars	$\frac{3}{32}$ in.	$1\frac{1}{4}$ in.
Jupiter	$1\frac{5}{16}$ in.	$2\frac{3}{4}$ in.
Saturn	$1\frac{1}{16}$ in.	$4\frac{1}{2}$ in.
Uranus	$\frac{1}{2}$ in.	7 in.
Neptune	$\frac{1}{2}$ in.	10 in.
Pluto	$\frac{1}{8}$ in.	12 in.

in oil or water colors. The sun is yellow, Mercury and Venus are white, Earth is green, Mars is red, Jupiter is orange with stripes for the cloud bands, Saturn is yellow with stripes for its cloud bands (Saturn is also provided with a ring made of cardboard with an opening to slip over the planet), Uranus is blue, Neptune blue-green, and Pluto is yellow. When completed the model looks like this.



With so small a model it is not possible to add the moons. Models such as these require considerable discussion so that children recognize their limitations. Otherwise misconceptions are apt to arise. All they can do is show comparative sizes for the planets. The distance scale merely shows proportional spac-

ing since the size scale applied to real distances would require the wires to be hundreds of feet long.

Another type of project which children enjoy is a chart to show planets' distances and the time required to reach them at various speeds. It offers good arithmetic correlation to get the right figures. We first get the real distances from books and then figure the time needed to cover them in a train going at 100 miles an hour, a plane going 400 and a rocket ship going 25,000 miles an hour. (This is the speed of release from the gravity of the earth.) These figures are then made graphic by drawing the earth in one corner of the paper, the selected planet in another, and pictures of a train, plane and rocket ship headed for it with the statistics along the routes.

Still another activity is a group plan for an assembly program at the end of the study in which they display all their projects and give an illustrated slide program. Each child makes a slide on some phase of the work and gives a short talk as it is shown. These slides are drawn on frosted glass and projected by a regular slide projector. This type of activity offers a fine motivation all through the study.

Besides being centered around real and interesting activities the teaching itself needs to be dramatic. Instead of stating plain facts teachers need to be original enough to turn figures and facts into things which children can visualize. Much of the fascinating material of astronomy can be told in story form. In class discussions facts can be presented in ways which children will find meaningful. For instance, instead of saying that Pluto is nearly four billion miles from the sun, a number which means nothing even to adults, I try to have children visualize the comparative distance by showing them on their Solar System models that Pluto would really be almost 4000 feet from their sun model. Then we discuss where the 4000 foot circle would go in our city. The mental image that results is real. The unusual, the novel, always appeals and it is well worth the teacher's effort to find new ways of saying things.

Children like to act things out and we sometimes go outdoors to dramatize the solar system. We measure our school grounds to find what limits our scale needs to have. Then we figure out the distances for the various planets and put children in those places. They then try to move around a "sun" child in orbits at the relative speeds of the planets they represent. Each planet is accompanied by the correct number of "moon" children. Ob-

viously this type of dramatics requires a knowledge of the basic facts about the Solar System and helps to make them impressive. There are many possible variations on this theme.

Children should have the experience of seeing the things they study about. A night meeting under the stars with the teacher to show them the constellations and planets is a rare treat. If a telescope, opera or field glasses are available so much the better. Often there are persons in the community who own such things and who are willing to lend or bring them for the children to use. In some areas it may be possible to visit a real observatory or planetarium. Such visits are highlights of school experience which children never forget.

Besides being presented dramatically the study should be rich in content. Astronomy is a major science and needs to be considered as such. It is not enough to do a bit of work on some small phase of it and then stop. Content should be complete enough so that children begin to grasp the deeper significance of the work of astronomers. The outline given above will give an idea of the scope of the subject. There are scores of fine books for pupils and teachers in every library to supply the needed information.

It takes more than a week or two of astronomy to make a good impression. My thought in teaching astronomy goes beyond the facts involved. I am more concerned with the attitude which children have toward their world and the universe of which it is a tiny part. I hope to have them grasp the majestic greatness of the space which surrounds us, the universal laws which govern everything in space, the insignificance of man as an individual organism, together with the added significance and greatness of man's soul and mind which can understand such things. I hope to have children feel something great and good when they raise their eyes to God's heaven; something that goes far deeper than facts or figures ever can, a consciousness of God.

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#### GYRO TRACK RECORDER CARS

Gyro track recorder cars, attached to a railroad train, make a continuous record of the track condition. Eight pens record on a moving tape irregularities in curvature, alignment, surface variations and other faults in the tracks. The rate at which the tape moves is in direct ratio to the speed of the train.

## THE TEACHING OF ELECTRIC CIRCUIT PRINCIPLES

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A major difficulty in teaching science—particularly physics—at a secondary school level is making certain that each student understands each fundamental law as it is met with in the progress of the course. *Understanding* a law implies to me not only the passive ability to state and illustrate it, but the active power to use it in solving the problems of a strange situation. Even after demonstration, class work, recitation, and review, a topic will be found, I note at times, to be by some not mastered after all; in fact, it is not unusual to find some important point thoroughly misunderstood!

Any teaching technique that promises to bring responsibility for mastery home to the individual student is worth attention and, possibly, a trial.

In spite of careful drill on Ohm's law and its implications, I have found students—some of excellent ability—occasionally reasoning in absurd ways about the current or potential distribution in the more complex circuits associated with meters, generators, motors, power systems, and simple radio sets.

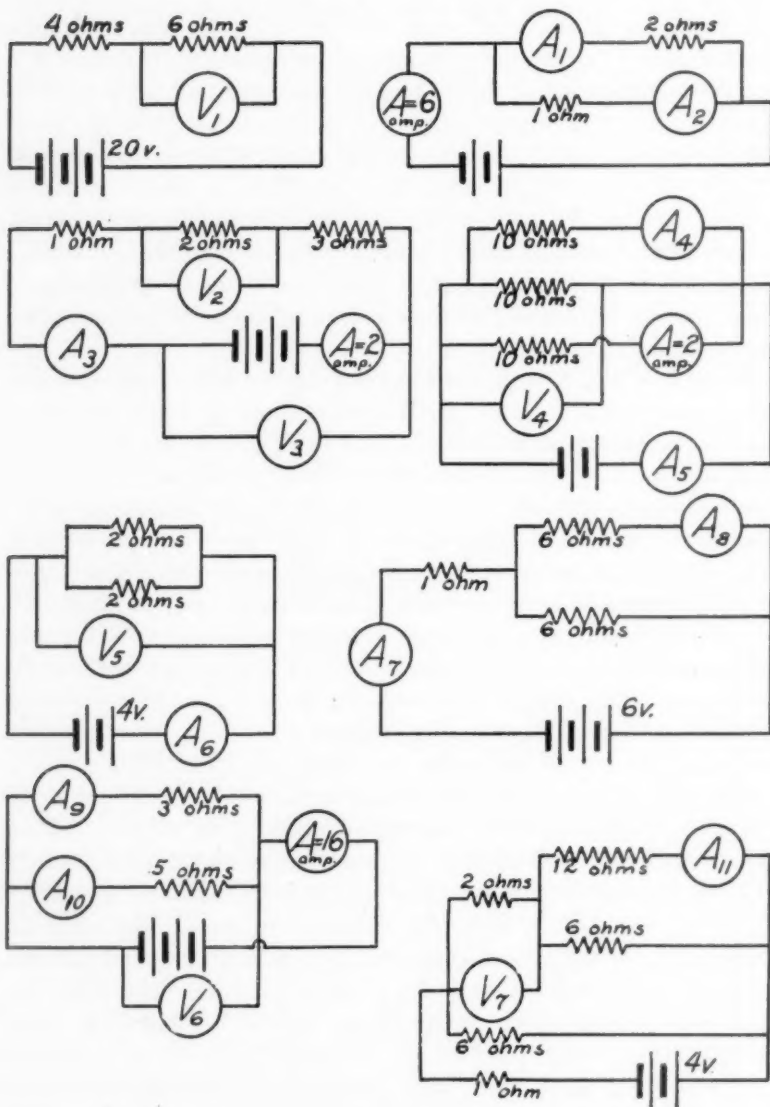
The following is an attempt to obviate this condition. After annual revision for five years, records comparing results obtained with some five hundred students show that it is to a large extent successful in attaining its aim.

After a class period spent in careful study of Ohm's law in simplest circuits, including the concept that fall of potential due to  $I$  amperes flowing through  $R$  ohms is  $RI$  volts, combinations are studied. First the relations in series circuits of resistances, current intensity, and electromotive forces are examined in that order, with frequent reference to water-flow analogy. Then the currents, electromotive force, and resistance relations, in that order, are taken up for parallel resistors. The next day, no work having been assigned for written preparation, each student is given a copy of the accompanying set of problems (or one of equal difficulty and progressive complexity), and the class proceeds at once to supervised study.

The best students rapidly work through the entire set with the gusto of the amateur puzzle-solver, and in twenty minutes

or so begin to ask, "Can't I have some more like these?" (I see that there *are* more!)

The students of medium ability are balked a little, but after being questioned on the principles involved in the first two or



The diagrams show voltmeters, V, and ammeters, A, distinguished by subscripts. Find the reading of each meter.

three examples, shoulder the responsibility and progress through the whole page in a class period of forty to forty-five minutes. Many of these ask spontaneously for a new set for outside practice.

The slow ones sit in helpless despair, or try skipping from problem to problem in hopes of discovering an obvious solution here and there. These are warned to work consecutively, and are shown exactly how to apply the principles that have been explained. A small group will have drill on problems involving difficulties exactly like those on the question sheet before they feel able to proceed independently. No actual solutions are given out in any case, but as the period approaches its conclusion the correct answers are posted on the blackboard so that everyone can ascertain his own progress in detail. A few will need detailed step-by-step explanation of several of the circuits before they understand them.

Frequently, a reminder is all that is necessary:

"That voltmeter? Voltmeters have such high resistance that you can pretend for the time being that it isn't there at all."

"How does current divide among parallel resistors?"

"Have you tried  $I = E/R$  for the *whole* circuit?"

In almost no cases are students left feeling discouraged or dismayed. When, later, the shunt generator is studied, the increasing  $RI$  fall of potential in the armature due to increase in the load current seems obvious to most, so that its characteristic regulation is comprehended without further analysis. Likewise, the effects of distributed load on a distribution system, such as chandelier wiring or farm loads strung out along miles of line, are taken in stride. No special new formula for circuits in which cells or generators have internal resistance is mentioned, or needed. In brief, new circuit arrangements are attacked with confidence and even pleasant anticipation. Bridge circuits, and others requiring Kirchhoff's laws, are of course not considered.

To summarize briefly: Handling this day's lesson in the manner described secures real mental activity of a kind that is keenly enjoyed by most students. Those who fail of real mastery realize their failure and feel the pressure of their mates (not the teacher) to put in extra time and energy to attain at least a passable understanding of the subject. The general result is a comprehension sufficient for all the types of questions that arise in the subsequent topics of the first course, and a good foundation for higher study.

## THE GEOGRAPHY OF RATIONING\*

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### INTRODUCTION

This is a global war. Screaming headlines, colorful maps, constant radio reports, overseas relatives and even rationing strip far-away places of their unreality, of their fairylike glamor and romance, and reveal them as geographical realities of vital interest and strategic importance to us.

The average citizen of America struggles desperately to keep pace with current military events in these distant areas. However, he limits his efforts to the location and pronunciation of these places. He pores over atlases and newspaper maps in an effort to orient his thinking about these turbulent current events. He is wholly ignorant of the climates, the topography, the industries and the cultures of the peoples living in the various regions of the world which now appear in the limelight of the news. All too frequently this ignorance of geographical conditions leads him to become dissatisfied with the war policies and strategy of our government.

Our leading military men, economists, geo-politicians and geographers admit that much of the early success of the Nazis in this war period was due to their near perfect synchronization of military activities with the geographical conditions, that is, with the physical features and the cultural heritage of the country under attack. Few Americans are aware of the fact, nor yet receive much comfort from the fact that our own government is guided, in part, by highly trained geographers. Some two hundred of these highly trained geographers from all parts of the United States are gathered in Washington to lend advice in procedures relating to the manifold phases of a global war.

We need, however, more than trained geographers as advisors in the national capital. We need a public, well-versed in the basic understandings of all places in the world in order to create and maintain a lasting world peace, i.e., a peace that will be real, living and workable only through more equitable access to the natural resources of the world. A foreign geographer re-

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\* Delivered before the Geography Section of the Central Association of Science and Mathematics Teachers, November 26, 1943.

cently described the United States as a "sixty per cent nation." He said, "It seems that you have nearly sixty per cent of all the major resources of the world." It is true, we do have nearly sixty per cent of most of the leading developed resources of the world, yet we have only about fifteen per cent of the people of the world. Our resources must, therefore, help to supply less fortunate peoples until such time as their potential resources can be developed to supply them with a sufficiently high standard of living to keep them from becoming dissatisfied, for dissatisfaction breeds wars, inasmuch as a deprived nation yields to the leadership of the reckless war-mongers. Accordingly, the citizens of our nation must understand and appreciate the necessity for temporarily making available to less fortunate peoples some of the critical products of our highly developed natural resources. A knowledge of the industrial, commercial and agricultural potentialities of the various post-war nations of the world is absolutely essential to a happy and complete understanding of post-war problems.

A thorough and intense program of scientific geography in our schools is only one way of acquainting our future citizens with the underlying principles of a lasting peace, yet it is a very important phase of the present war and the post-war program.

This demonstration lesson will attempt to show how the skills learned in the classroom are used in thinking through current events in this war. The subject of the lesson is *The Geography of Rationing*. Time will not permit us to discuss every rationed product in the light of our geographical knowledge, hence we will discuss only a few of those rationed products about which the children have a thorough geographic background for use in the thinking process.

#### THE LESSON

Rationing is a new thing in our lives. Two years ago we had no ration books. We bought what we pleased and as much of it as we pleased. Today many products which formerly were plentiful are rationed and many others are scarce.

In today's lesson let us see if we can find a few of the reasons why some products are very scarce these days and why others are being rationed.

Name some of the products which are rationed. (Answer: sugar, meat, shoes, canned goods.)

Name some of the products which are not rationed but are very scarce. (Answer: chocolate, bananas, rubber goods, tea.)

Sugar was the first item rationed and probably has affected all our lives in one way or another.

Where are the chief sugar producing regions of the world? (Answer: the West Indies, Central Europe, India, Java.)

Locate these areas on the map.

What are the two sugar producing plants? (Answer: Sugar cane and sugar beets.)

In what kind of regions is sugar cane raised? (Answer: In low-latitude regions.)

What are the low-latitude regions? (Answer: Regions near the equator.)

What kind of a climate is necessary for the production of sugar cane? (Answer: A year-round growing season plus a marked wet and dry season.)

Yet we do raise some sugar cane in the United States. Where? (Answer: Louisiana.)

Why is this possible? (Answer: The farther you get from the equator the more sunlight per day. Louisiana has about as much sun in 10 months as Cuba has in twelve.)

In general, in what kind of places is beet sugar raised? (Answer: In middle-latitude regions.)

What are middle-latitude regions? (Answer: Regions having latitude numbers about half-way between  $0^{\circ}$  and  $90^{\circ}$ .)

Who is the largest producer of beet sugar? (Answer: Ukraine of Russia in peace times and central Germany.)

Name four large consumers of sugar that do not produce enough sugar for their own use. (Answer: United States, British Isles, China and India.)

From where did we import sugar before the war? (Answer: Cuba, Hawaiian Islands, Philippine Islands.)

What reasons can you give for not importing sugar from all of these places now? (Answer: The Philippines are controlled by the Japanese, and the distance between us and the Hawaiian Islands is so great that shipping is handicapped by the submarine menace.)

Cuba, however, is not so far from us; she produces large quantities of sugar and the submarine menace is decreasing. What reasons can you give, other than the deprivation of a small part of our source of sugar, for rationing sugar in the United States? (Answer: We must share our sugar with those of

our allies who cannot get sugar now due to the war conditions.)

Which of our allies need sugar? (Answer: British Isles, China and other nations freed from the Nazi yoke.)

Where did the British Isles buy their sugar before the war? (Answer: Central Europe and the East Indies.)

Why, then, must we share our sugar with the British Isles? (Answer: Since both former sources are enemy territory her supply is entirely cut off.)

What route would the ships ordinarily follow in sending sugar to the British Isles? (Answer: The arc of a great circle between those two places, because the arc of a great circle is the shortest route between any two places on the curved surface of the earth.)

Show us this route on the globe.

Why are the sugar boats taking a different route now? (Answer: Because of the submarines and the fact that ships travel in convoy groups now.)

Why are we exporting sugar to China? (Answer: China's source of sugar was the East Indies which are now controlled by the Japanese.)

Why doesn't China import her sugar from India, since India is one of the four great producers of sugar? (Answer: Although India produces much sugar, her dense population requires more sugar than she can raise, hence India is herself an importer of sugar.)

We ration sugar, then, as part of our program to keep the United Nations united. We must share with those nations who are temporarily deprived of their sugar supply.

Coffee is another product that had to be rationed for a while. Where is most of the world's supply of coffee raised? (Answer: Southeastern Brazil.)

How much of the world's demand for coffee could Brazil raise? (Answer: More than 100%.)

Locate this area on the map.

Can you give me a reason why coffee was rationed for a while? (Answer: We do not raise any coffee. We must import it. Our shipping space was too valuable to use for importing coffee, and the submarines made the risks of shipping too great.)

Suddenly we stopped rationing coffee. What reasons can you give for this sudden change? (Answer: The submarine menace decreased. Brazil's economic welfare depended to a large extent on her export of coffee, her chief commercial product. When

her coffee market was cut off she experienced a depression. A country in the throes of a depression does not make a good ally.)

Chocolate and cocoa are not rationed but they are scarce. What is the raw material from which these products are made? (Answer: Cacao.)

Where is cacao raised? (Answer: East coast of Brazil, the Guinea Coast of Africa, scattered areas in northern South America and in Central America.)

Locate these regions.

Can you think of a reason why chocolate is scarce and not rationed, or why we do not have the same quantities of chocolate in our country that we have of coffee? (Answer: The economic welfare of none of the countries raising cacao depends so critically on the sale of cacao as does the economic welfare of Brazil on the sale of coffee. Chocolate is needed in the emergency kits of the armed forces.)

Let us summarize the reasons we have found for rationing.

#### SUMMARY

The reasons for the rationing of other goods which we have not taken up in detail today makes an interesting study, too. The rationing of meat and canned goods, for instance, involves many facts which we did not need to help us explain the rationing of sugar, coffee, and chocolate. Some time soon we will discuss these facts which help explain the reason for rationing other products in our current events period.

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#### MRS. ELEANOR ROOSEVELT ON FEDERAL AID TO EDUCATION

"I was discussing Federal aid the other day and I began to wonder whether we citizens of this country really know that we have had Federal aid for education for a long time. It began first under the Morrill Act of 1862, which gave grants of land to the states and started our first land-grant colleges. . . .

"Yet I have never heard the slightest complaint that they were used to force unwelcome restrictions or changes in programs of the various colleges. . . .

"Population trends show us that we move about more and more in this country, and a child educated in one place may spend his working life in another part of the country.

"Poor education received in one place does not of necessity affect the place where the child is born and educated. It affects the well-being of the entire nation. Then our nation as a whole should be interested in equalizing educational opportunity through our whole country."

## THE WORK OF THE CHEMICAL WARFARE SERVICE\*

LT. COLONEL WILLIAM O. BROOKS, CWS

*Washington, D. C.*

Six weeks ago today General Mark Clark's Fifth Army stood on the south bank of the Volturno River in Italy. Crack German units were organized in depth on the opposite side, blocking the road to Rome. The Volturno is a stream of considerable size and the successful crossing of this water barrier illustrates the important part our Chemical Warfare Service is playing in active combat on the firing line.

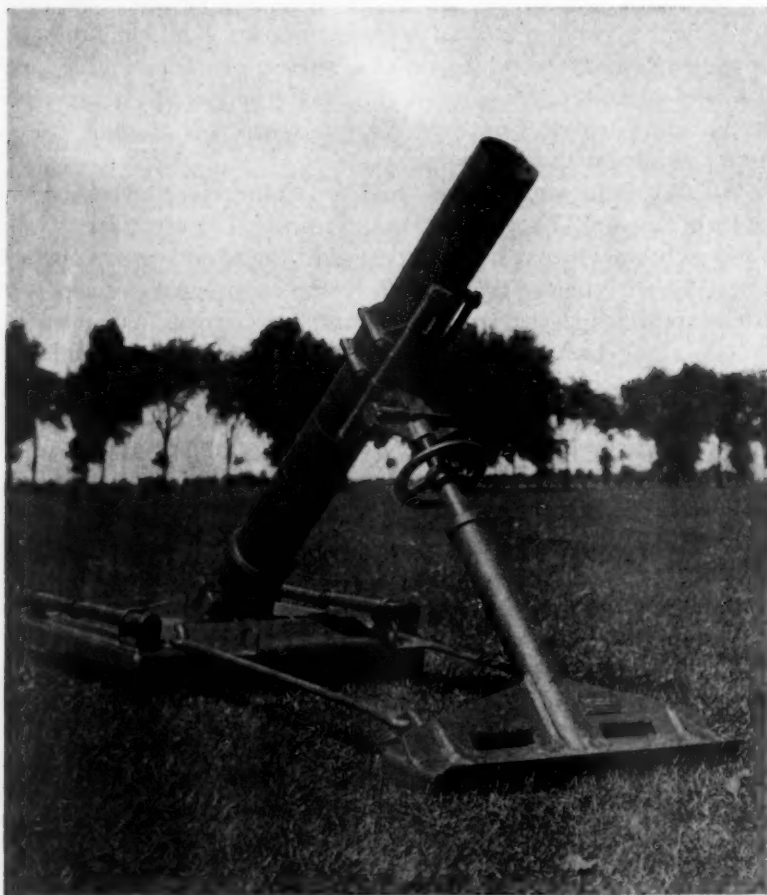
All day long our artillery blanketed the German positions with heavy fire. Throughout the evening salvo after salvo was fired at the north bank of the river and the enemy positions beyond. Shortly before two o'clock in the morning American soldiers approached the river bank and took cover in fringes of woods along the southern shore. It was a brilliant moonlight night with a cold north wind howling. The twisting river looked like a chain of silver horseshoes as it glistened in the moonlight. But danger lay ahead, for every German gun along the 40-mile front was ready to open fire as soon as the Americans plunged into the neck-high, icy water. Infantry would have to wade or swim across 60 to 100 yards of water to reach the opposite bank. Combat engineers would have to throw temporary bridges across the river for the heavy weapons needed to support the assault troops. The river had to be crossed, yet without some form of protection our losses would have been ghastly.

At 1:59 A.M. exactly the artillery preparation ceased. There was a sudden deadly silence. Then came a sudden burst of fire, and the German side blossomed with brilliantly flaring smoke shells, each producing a great puff of white smoke. More and more smoke shells were pumped into the American guns and each gave its brilliant flare followed by a white cloud of smoke. In a matter of seconds the clouds joined together and blanketed the German side in a pillar of white smoke so dense that the enemy could not see three feet ahead. Behind that smoke screen our troops moved forward to the river bank and stepped into the cold water. Cautiously they moved toward the opposite shore. As they felt the opposite bank under their feet they scam-

\* Address delivered at Annual Convention of Central Association of Science and Mathematics Teachers, Chicago, Illinois—November 27, 1943.

pered up onto the dry land and disappeared into the drifting pall of smoke. Engineers followed with pontoon bridges. The river was successfully crossed.

"There was never a more beautiful or spectacular battle," wrote one war correspondent, "than the one which unrolled in the moonlit Volturno Valley as the chilly night wore on." We



4.2-INCH CHEMICAL MORTAR

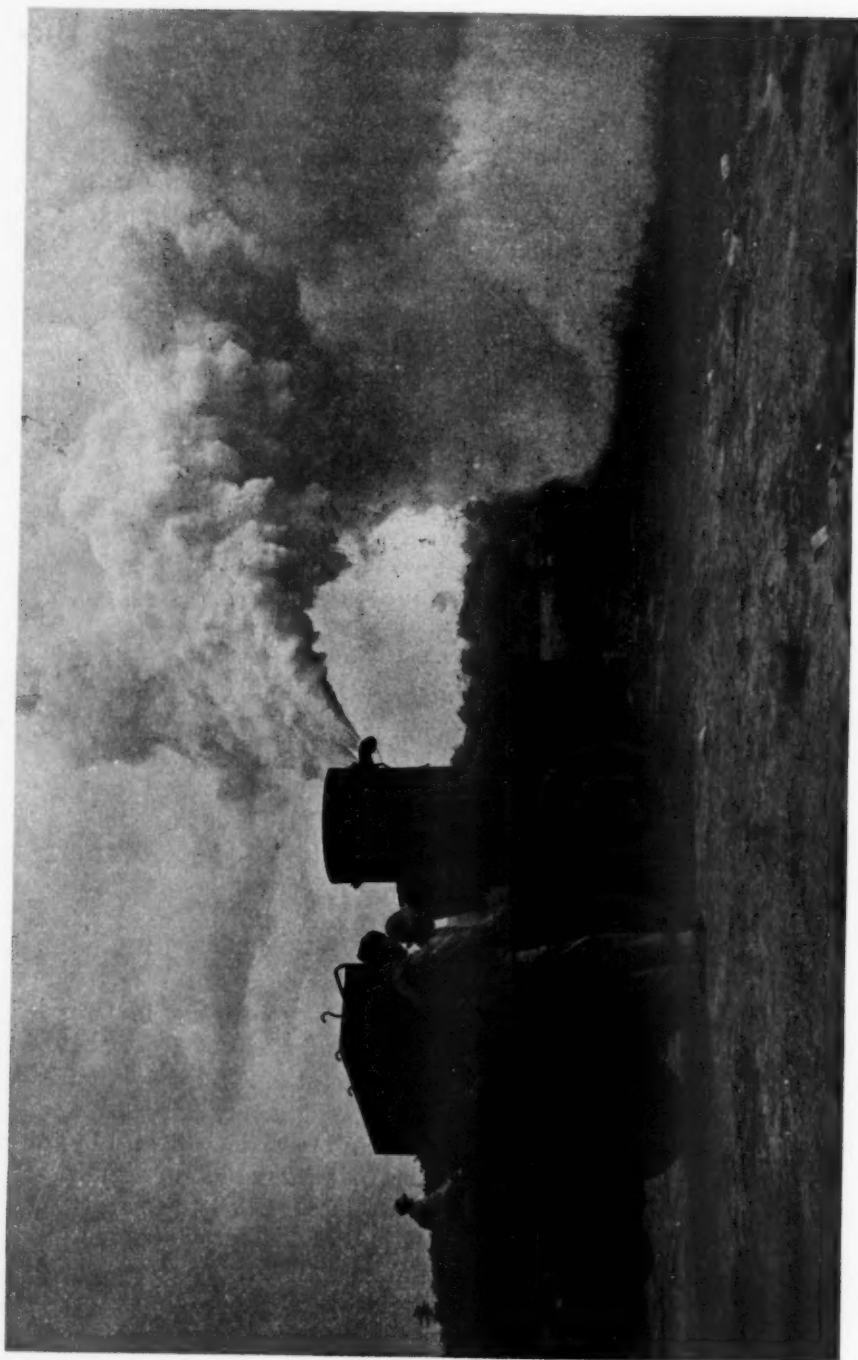
suffered casualties, of course. Such an operation cannot be carried out without costs. But that protecting blanket of smoke, that white cloud that covered the German positions, saved thousands of American lives and made the river crossing possible.

That smoke screen was the contribution of the Chemical War-

fare Service. Smoke is one of the weapons of modern warfare with which the Chemical Warfare Service is fighting today on all fronts. It was used in Tunisia, in Sicily, in Italy and also in the Southwest Pacific area. Smoke covers infantry advances and shields rear areas against air attack. Sometimes it is sprayed by plane, sometimes it is fired by artillery, but most often it is laid down by our 4.2 inch chemical mortars, by our smoke pots or by our mechanical smoke generators.

We have found that white phosphorus, an incendiary agent which burns spontaneously when exposed to air, is the most successful. It has an obscuring power far greater than other smokes and in addition it has a pronounced psychological effect against enemy troops exposed to its flaming particles. In Sicily, 25-lb. shells filled with white phosphorus, fired by CWS troops, scattered blazing pieces of this element as they burst among the fox holes of the enemy. Burned by the phosphorus and blinded by the smoke, the Germans left their fox holes only to be hit by shell fragments from high explosive shells fired by the same CWS troops. In military parlance we might say,—the operation was completely successful.

The invasion of Sicily brought forth a new weapon which has proven to be phenomenally successful,—the 4.2 inch chemical mortar. Developed by the Chemical Warfare Service a number of years ago, this remarkable piece of portable artillery received its first real battle test in the conquest of that island. Mortars are "old stuff" but the distinctive feature of this gun is that it is rifled, thus imparting true flight to the projectile and greatly increasing the range and accuracy over the smooth-bore mortars used in World War I. The barrel has a diameter of 4.2 inches or approximately 107 mm. Muzzle-loading, with no breech blocks to open and close, the piece has a fire power as high as 20 rounds per minute. A ring of soft copper at the base of the shell is mushroomed by the expanding gases from the powder charge and this coppered ring engages the rifling, giving true flight to the shell. Since the mortar weighs only 300 lbs. and is readily dissectible into 3 pieces, it can be carried forward by the gun crew over rough terrain that is impassable for regular artillery. Constant research has enabled the CWS to increase the range of this mortar to more than 2 miles! Just how much further it will shoot will have to remain a military secret for the present. And accurate,—the way it hits the target is almost uncanny! With the excusable exaggeration engendered by pride



M1 MECHANICAL SMOKE GENERATOR IN ACTION

in their weapon, CWS mortar battalions claim they can "hit a dime" with it. But let me tell you of one remarkable shot that really did occur in Italy a few weeks ago. A German tank came lumbering along with turret cover open, innocently unaware that a 4.2 chemical mortar was within range. Suddenly a flash of fire came from the 4.2 and the 25 lb. shell filled with HE whistled skyward and then dropped right into the open turret of that German tank! The devastation created when the 8 lbs. of TNT underwent a process of molecular disintegration within that tank can well be imagined! Frankly though, our mortar battalions do not guarantee such remarkable shooting with every shot. Do you wonder though that we who wear the Crossed Retorts take great pride in this contribution to victory which was developed by the Chemical Warfare Service?

The Chemical Warfare Service has developed other weapons which are proving to be extremely useful in the present conflict. The flame thrower, that awe-inspiring, spectacular device that shoots blazing oil 50 yards or more, has been extremely successful in wiping out Jap machine gun nests in the jungles of New Guinea. The mechanical smoke generator produces a harmless and almost odorless white smoke in prodigious quantities to protect rear areas, harbors and canal locks. The harbors of Algiers and Bizerte in North Africa have been blanketed with smoke from these generators so successfully that enemy air attacks on our shipping at these ports have been total failures.

The floating smoke pot is useful to set up smoke screens on short notice, either to screen vessels, to cover landings or to assist in river crossings. They look like 5-gallon cans of lubricating oil and contain a burning mixture of hexachlorethane. Once ignited by a pull on the ignition wire they can be tossed into the water, bob to the surface, and continue to function, giving out dense clouds of white smoke for 15 to 20 minutes.

Colored smoke grenades have been developed as signalling devices. In dusty areas it is often difficult to distinguish friendly from hostile tanks. The colored smoke grenades which we produce in all colors of the rainbow have proven to be extremely useful for many purposes when fired according to a prearranged color scheme for identification. These grenades contain burning mixtures of smokeless powder which volatilize special dyes giving very pretty color effects.

The Chemical Warfare Service abounds in many interesting new developments, but in addition we have other more prosaic

but none the less important projects. We protect all our soldiers by providing masks that will protect against all war gases. The military gas masks that are issued to our troops today represent as great an advance over World War I models as our trucks and jeeps surpass the vehicles used in 1917. We believe our U. S. Army gas masks are the best in the world and base this opinion on the results of examinations and rigorous tests conducted upon the gas masks of our enemies.

An interesting sidelight in this connection is the important research on activated carbon which has been carried on by chemists of the Chemical Warfare Service. During the last war activated carbon was made from coconut shell, a raw material which yields a dense form of carbon with high adsorptive capacity. Recognizing that in the event of a Pacific War our nation might be cut off from a supply of coconut shell, the Chemical Warfare Service studied the problem of producing activated carbon from domestic, non-strategic sources. We have been successful. Today activated carbon made from wood, coke, soft coal and even sawdust is produced in tremendous quantities of a quality far superior to the activated carbon made from coconut shells in 1918. The foresight of the CWS in this development is paying rich dividends now that we are unable to import coconuts from the South Sea Islands. In fact, we may well see a new industry developed in this country after peace returns,—the increased use of activated carbon, made possible by the low costs which have resulted from large-scale production from cheap raw materials. Besides the recovery of solvent vapors in chemical industries we may see activated carbon units employed to adsorb objectionable odors in public buildings, restaurants, kitchens and household refrigerators. Just think of the possibilities for a few such units in the dressing rooms of school gymnasias where the odor of perspiration is usually so annoying!

One of the most important functions of the CWS is the training of all of Uncle Sam's armed forces against chemical attack. In our Chemical Warfare School at Edgewood Arsenal classes are conducted, not only for the Army, but also for the Navy, Marines and Coast Guard. Selected officers and enlisted men are acquainted with the latest methods of defense against chemical agents. The graduates of this school then return to their units and impart what they have learned to the men in their organization. In this way our armed forces are trained so that

should our enemies resort to gas warfare our soldiers and sailors will not be caught unawares.

The Chemical Warfare Service has a varied list of functions. This branch of the army is unique in that it is the only arm or service to conduct all of the following activities:

1. Research and development
2. Procurement and manufacture
3. Inspection, testing and proving
4. Training officers and men of all the armed forces
5. Combat on the firing line

Our research is conducted at our Technical Division at Edgewood Arsenal, supplemented by laboratories at Massachusetts Institute of Technology and Columbia University and assisted by hundreds of the leading scientists of the country who are carrying on confidential researches at many colleges and universities.

American Industry in hundreds of factories and chemical works is producing thousands of different items of equipment and material needed for our procurement program. In addition to these we have several large arsenals and chemical plants of our own which are turning out necessary materials for offense and defense purposes. Few persons realize that we make all the incendiary bombs that are being dropped each night by our Air Forces on German industrial centers with such devastating results.

Our incendiary program is our largest procurement activity. Millions and millions of magnesium, thermit and solidified oil bombs have been manufactured both for our own Air Corps and also for the Air Forces of our allies. When you read in your morning newspaper that a large number of planes dropped tons of bombs the night before on a German industrial center, you can be sure that a certain proportion of the "pay load" was made up of incendiary bombs manufactured by the CWS.

Our training has already been mentioned. The importance of a well-trained army in defense against chemical attack cannot be overemphasized. Gas is a psychological weapon since it is instinctive in man to fear the strange or invisible or unknown. By overcoming that instinctive fear through building in our soldiers a confidence in their gas masks, as well as a knowledge as to the proper course of action in the event of a gas attack, we

can nullify the results which our enemies would hope to secure by surprise.

Our greatest pride today, however, is the brilliant achievements of our fighting units at the front. Armed with the now-famous 4.2 chemical mortar, they have given a splendid account of themselves. To date they have fired smoke, incendiaries and high explosive. Should occasion require they can fire shells filled with war gases in the same weapon.

Doubtless you are all wondering "When will gas warfare start?" Frankly, I do not know. The best answer to that question which I can give is to quote our Chief of the CWS, Major General William N. Porter, who recently said, "We are ready. If our enemies resort to gas warfare we are prepared to retaliate and we can give them back a great deal more than they can send."

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#### AIRLINE PILOTS AFTER THE WAR

Airline pilots never will be "a dime-a-dozen" despite the large supply of flyers which will be available after the war, it was declared recently by W. A. Patterson, president of United Air Lines, in an address at New York.

Mr. Patterson, speaking before the American Steamship and Tourist Association, predicted that airline pilots would continue to be paid on the basis of their professional ability rather than on the basis of supply and demand.

"We hear it said pilots are going to be 'a dime-a-dozen' because a million boys are learning to fly in the war," said the airline executive. "Pilots are never going to be 'a dime-a-dozen' and if any of them are I don't want to fly with them.

"The airline pilot is a professional man. The law of supply and demand does not determine the compensation paid for professional services. Let us say there is a surplus of 100,000 doctors in New York City. But you do not select a doctor to operate on your wife or child on the basis of how cheap you can get it done. You want the best doctor you can get and you pay the fee he charges for the responsibility he assumes.

"Airline pilots are going to continue to be highly paid as long as they assume responsibility for the comfort and safety of the passengers who fly with them. Their professional knowledge and skill, not supply and demand, will determine their pay."

In his New York talk, Mr. Patterson predicted a five times growth of air transportation within four years after the war, but he warned that the airline industry must guard against "emotional thinking and planning" in order to avoid the ills of over-expansion which have plagued other forms of transportation. He pointed out that the industry had freed itself of subsidy support and he declared that the airlines should have no desire to return to subsidies.

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*When you change address be sure to notify Business Manager Ray C. Soliday, P. O. Box 408, Oak Park, Ill.*

## THE USE OF FILMS AS A TEACHING AID\*

ROBERT E. SCHREIBER

*Stephens College, Columbia, Missouri*

Last year Stephens College used over 4,000 reels of motion pictures in its classes and associated activities. 800 hours—or 48,000 minutes—of film showings. Now does that imply that the campus is largely an assemblage of motion picture theatres . . . does it suggest that the schools of the future will be only glorified cinemas with marquees announcing—"Now Showing—ADVENTURES IN SCIENCE—in Thirteen Terrific Episodes"? Will pupils all over the country stream to these places of education for four hours of screen instruction five days a week . . . and NOTHING else? Will teachers cease striving for Ph.D.'s and start working for projection licenses instead? Is such a nightmare possible?

In jumping to any such conclusions, one overlooks two salient factors: (1) Teachers, as a whole, are notoriously unaware of the values of films as a teaching aid; and (2) those who ARE aware of their importance are often lacking in the information necessary to their use. And, further, let's review those figures mentioned a moment ago. 4,000 reels of film—silent and sound; 48,000 minutes; 800 hours. Suppose it's 800 hours over a 36 week period—22 hours per six day week. That's only 3.7 hours of film showings per day, and—at Stephens—over 300 classes meet every day. And so, the nightmare is dispelled, and we settle back again complacently. But can we afford to? Are we missing something in NOT using motion pictures to a greater extent? What does their use accomplish as a teaching aid? Well, let's see. . . .

For purposes of exposition, let's bring the question right here to our situation this morning. . . . The speaker drones on . . . the audience listens politely . . . but, ARE YOU INTERESTED? Suppose you aren't. All right, then, why aren't you interested?

Studies have brought out that we learn mostly through our sense of sight; say 75% of our learning occurs through that sense. We learn about 25% through our sense of hearing—but not quite, since some learning occurs through taste, smell, and

\* Delivered at the Central Association of Science and Mathematics Teachers, Junior College Section, Saturday, November 27, 1943.

touch. Therefore, in putting this address across, I am operating at only about 25% efficiency. Now a similar thing is true of a class in which the instructor relies solely on verbalism to inform his pupils. In contrast to that, suppose I were to transport all of you to Columbia, Missouri, this morning—personally conducting you about the campus and pointing out how films are used as a teaching aid at Stephens College. Herein lies the essence of the Field Trip or School Journey—teaching through contact with or the use of definite objects and situations. Thus, by combining sight and sound we may assume almost 100% efficiency in instruction.

Now, such an approach wouldn't be practical this morning, but I MIGHT have been very ambitious before coming to Chicago and produced a sound motion picture which I might have shown to you—covering the same information as an actual visit. Provided that it were a good picture, it would have been the best substitute for an actual contact with our situation. WHY? Because—through sight, sound, and the very important MOTION—one thereby achieves the nearest thing to reality.

No doubt some of you are thinking at this point—"Why doesn't he show us some slides?" Yes, you have a point there. But in a slide, one loses something; that something is MOTION—and with the loss of motion, part of the REALISM goes, too. However, the slide—and its more modern counterpart, the strip film—has a very definite place as a teaching aid. In presenting material in which motion is not important to a complete understanding, the slide may well be used in place of a motion picture—and more economically, too. Similarly, maps, charts, pictures, models, and other visual aids may be used to advantage, where motion is not essential to the grasping of concepts.

Therefore, we may conclude that the primary use of the film should be that of presenting motion—by making the material more realistic—and hence more interesting and likely to "stick."

Now, how important is motion in its relation to the other properties of the motion picture? . . . Through the medium of the film, one may observe processes and things which it is not possible to see in any other way. Can you, for instance, demonstrate the process of plant growth—starting with the seed itself? Of course, you can plant seeds in a window box, removing a developing seedling from day to day, and indicating to the class what has taken place. And, eventually, you can demonstrate all of the STAGES of development. BUT, can you show

the CONTINUOUS process of development? Through time-lapse photography, motion pictures can! Are you able to show your classes the action of the human heart? Through animation, the film accomplishes this task. Can you show your pupils what happens when a bullet is fired from a gun—processes that occur faster than the eye can see? Slow motion accomplishes this miracle. Can you show them how erosion takes place, how a river progresses through its life cycle, how diastrophism molds the surface of the earth? . . . can you REALLY? You CAN show them different stages of things, what HAS happened, or activity which points towards some new development in the future. But, can you, without the motion picture show the complete and continuous change from beginning to end so helpful to a thorough understanding of many situations in nature? It is my belief that you cannot demonstrate these processes in other ways and come as close to reproducing what actually occurs as through the use of motion pictures.

I am NOT trying to imply that education without motion pictures is not complete. Imagination is a wonderful thing, and the ability to put across complete concepts from a series of semi-static illustrations is one of the things that make teaching the challenging vocation that it is. What I AM trying to suggest is that through the use of the film, concepts may be instilled more quickly and easily than by traditional methods. The Armed Forces realize it . . . Industry realizes it. When is the teaching profession—as a whole—going to realize the values of the motion picture and accept it as the useful tool that it is?

Use your charts and models, yes. Use your pictures and drawings and slides, of course. But when you want to show motion, change, development; when you want to encompass a week, a year, or a century in one class period; when you want the most realism possible without the actual situation itself—consider the talents of the motion picture. It won't take the place of you; it is a TOOL for your use.

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How is the progressive educational institution informing its staff with respect to the desirability and availability of films for inclusion in the curriculum?

At Stephens College the responsibility for informing instructors what films may be made available to them is shared by the library and the Visual Aids Office. By including its visual aids

program within the scope of the library, Stephens is making use of the most logical channel for disseminating this information—a channel already established and functioning as the agency to which teachers usually turn for assistance. However, the transition from the Visual Aids Office as a separate entity is not complete as yet, and that office remains—for the present—the major coordinating and service center on the campus. Assistance is given the faculty through film selection, projection service, methodology, and evaluation.

The details of projection are taken care of through a well-ordered routine and are given all due consideration; but it is the service involving aid in film selection to which the most time and attention are devoted. It has been found that often just a few films carefully selected and previewed by the instructor involved may result in another convert to the idea of films as a teaching aid. In this connection, extensive card indices are maintained for the use of the faculty and the office personnel. Whenever a new educational film is placed upon the market, a member of the latter group studies its description, and if it seems even remotely related to the wide variety of courses in the curriculum, a source card is made out for the title involved. This card includes information regarding: the physical characteristics of the film (i.e., whether it is silent or sound, monochrome or color, length, etc.) plus a list of the subject areas that it may be appropriate to. In addition, a description of the film content is recorded on the reverse side. Cards of this type are filed alphabetically and constitute the key source of information from which orders are drawn and other cards derived.

Course—or, subject area—cards, containing the subject matter data of the source card, are made out for as many divisions of study as are indicated on the master form—plus one. These course cards are then sent to the Divisional Libraries throughout the campus. Another complete file of all course cards is maintained in the Visual Aids Office—classified according to subject areas.

Following every exhibition of a film, an evaluation card is sent to the instructor thus served. When returned, these cards are filed with the corresponding course cards and serve as a basis for future film selection.

At this point another question naturally arises. Given an adequate, up-to-date source of information concerning available product, is the matter of informing the faculty settled? Quite

the reverse! Such an index only forms a starting point for extensive contact with faculty members for the purpose of discussing their interests, methods, and needs in the realm of the motion picture. True, many faculty members DO seek US out, and it is this interested, experimental attitude on the part of the staff at Stephens—fostered by a progressive administration—that has assisted in building the use of films on the campus to its present status of importance.

And, again, we must not forget the library, which assists to a growing extent in bringing films to the attention of divisions as a whole through the former's bibliographies which include motion pictures as well as the traditional printed materials. As has been mentioned previously, the Divisional Libraries also assist in this project by providing an index of films close to the instructors in a particular area.

The Visual Aids Office, however, still assumes the bulk of the personal contact work which has been found the most effective in bringing to the attention of faculty members motion pictures useful in their fields of interest. Activity of this sort generally progresses through patterns similar to the following:

A visual aids staff member, having several interesting titles in mind in each general subject field—or having noted a film showing promise of particular interest to some faculty member, mentions the matter of films to an instructor who is not in the habit of using these aids. Such a contact generally leads to a discussion of the subjects available in the field of the instructor's interest. The instructor usually favors seeing a list of some of the films available as a result of this conversation. Our staff member feels at this point that he at least has his foot-in-the-door, and sends the list—properly annotated—to the faculty member at the first opportunity. This list usually piques the curiosity of the latter, who may then do one of several things: (1) Some of our suggestions may have hit the nail right on the head, and the result is a fairly immediate order; (2) he confers with other members of his department and asks to preview several films; (3) or he may come in for another chat about films and a look at our card catalog. Of course, his acceptance of the list may have been only a polite gesture on his part, and nothing happens. In such cases the Visual Aids Staff continues offering information and suggestions, and in due time a favorable attitude is usually established and the new convert begins using films.

It should not be concluded, however, that—once a teacher has begun to utilize motion pictures—we consider our job done and forget about him in the interests of a new campaign. No, this welcoming, interested attitude must be guided and stimulated until the use of films is firmly established as a part of the instructor's methodology. Even then, the interest of the Visual Aids Office does not cease, and teachers are kept informed of new offerings in their fields of interest. Thus, from the contact that brings the first flicker of interest until the use of films as a teaching aid is firmly established, the Visual Aids Staff follows through unceasingly.

The Visual Aids Office considers itself a service agency; no assistance that it is physically possible to render is refused any teacher asking it. This spirit of cooperation has done much to further the use of films as a teaching aid at Stephens College; it is an attitude upon which rest the success or failure of the visual aids program in any institution—and one which those at Stephens fortunately realized when the program had its inception. In the myriad details involved with routine and other matters, this spirit of cooperation must be cultivated and not forgotten.

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As a result of the foregoing informational activities, how are films being used as a teaching aid at Stephens College? The evaluative form—included in the course card index, after experimentation and observation over a period of years, lists eight ways in which films are utilized:

1. Motion pictures are used as an introduction to a subject or unit.
2. To provide a general background for fuller appreciation of course materials.
3. To make the material of the course more vivid.
4. To make the material more interesting.
5. To present material which cannot be presented better another way.
6. To clarify material already covered.
7. To give additional facts on a subject already covered.
8. To serve as a summary.

The use to which a film is put is determined largely by the nature of the film itself. Motion pictures of a general nature consequently fall into the category used as introductions and

summaries, or they may be inserted in the middle of a unit to enliven interest in the course. Films of a more specific nature are more closely correlated with subject matter. The use to which films are put also depends upon the classification of the film, i.e., whether it is of a type used as an informational or stimulative device.

The extent to which films are available in a given field is another determiner of the uses to which they are put by the instructor. Since the matter of visual education assumed its first prominence, science teachers have been given the lion's share of attention by the producers of educational motion pictures. This is reflected at Stephens by the fact that out of the first 400 titles used this year, 50% have been shown to classes in the Science Division. In such situations, one finds the highest correlation of film information with course content—as well as some of the best integration therewith.

Of the first 400 films, 16% have been shown to classes in the Vocations Division—principally the Aviation and Radio Departments. The large number of aeronautics subjects being released by the Signal Corps has accounted for the increased use of films in this division, whereas only a year ago the product in this area was rather meagre. Offerings for Radio are of a general nature used largely as introductory materials.

In the languages division (accounting for 14% of the showings), foreign language features prove most helpful in furthering grammatical usage, while shorter films on the geography and customs of the countries involved stimulate interest and furnish background material.

In the Division of Social Studies—particularly in social problems, international relations, and geography—the number of films that may be appropriately brought into the curriculum is probably the greatest in any field. However, since many of the usable offerings are not specifically pointed towards the subject area, selection is more difficult. Nevertheless, there is a vast reservoir of material, scarcely tapped. Films of a definite historical value are less prevalent than those on current topics. A similar problem of film selection exists for the Division of Religion and Philosophy, where the surface has just been scratched on available product.

In the Division of Home and Family, films of the Human Relations Series—cut from professional productions of the past ten years—figure prominently—along with a number of sub-

jects on Child Study. Films of the former group are of value more through their implications than by making their points "one-two-three."

Although motion pictures are used to a relatively small extent in the Division of Communications, the films that ARE shown have been utilized in an interesting manner. News subjects have been used in Journalism classes as a substitute for actual situations. Students observe what transpires in the news reel and report upon the incidents as if they were present at the scene. In this way, material of a scope not locally available is brought within the confines of the classroom. A similar method of reporting simulated news has been explored somewhat in Radio classes.

Another instructor in the Communications Division has demonstrated the most outstanding use of films as a stimulating agent in the classroom situation at Stephens. Cuttings of the Human Relations Series—in addition to other subjects of value—are viewed. These exhibitions then act as springboards to class discussions in which related problems are brought up for exposition, and the writing of papers and other projects result. Those who have worried about the small number of films specifically pointed towards English courses may well find in such utilization a source of inspiration and enthusiasm. It should not be construed, however, that such utilization need be limited to the Communications Classroom, since such methodology is the substance of proper use of the motion picture in any situation. Indeed, it is in this way that the film may achieve its major aim of reproducing in the classroom occurrences that may not be presented adequately otherwise—for discussion and the accompanying learning that accrues.

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Thus, through a system of Visual Education in which information is proffered to the cinematically uninitiated, assistance provided in finding appropriate films—once the interest has arisen, plus an accepting, experimental attitude on the part of instructors—may evolve a utilization of the motion picture, which—if generally adopted—augurs well for education in general and the future well-being of mankind!

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Sleeping cars especially designed for troops will soon be in service. They have a triple-deck berth arrangement, the berths being placed cross-wise. The middle and lower berths fold into comfortable daytime seats. The uppers are fixed and may be used for baggage.

## NERVE GROWTH AND NERVE REPAIR\*

PAUL WEISS

*The University of Chicago, Chicago, Illinois*

This is a war of nerves in more than one sense. The incidence of nerve injuries is likely to be high, disability resulting from permanent loss of sensation and movement serious. A limb whose nerves are cut is useless: communication lines gone, brain and spinal cord can no longer control it. Not unless and until the lines are restored. Fortunately, the damage need not be irreparable. Nerves have the power to regenerate. If we wisely help their efforts, nerve regeneration will lead to functional repair.

A nerve is a cable of microscopic threads, each one-thousandth to one ten-thousandth of an inch thick. Each fiber consists of a core or axis, embedded in a string of accessory cells, the whole enclosed in a tubular sheath. The axis is the conductor in which the nerve impulses travel. The surrounding cells presumably have nutrient function, and the sheath serves as container. Each axis fiber originates from a cell in a nerve center, such as brain or spinal cord; its very life depends on its remaining connected with that cell. When divided, the cut off portion disintegrates, while the sheath survives. Figuratively speaking, the isolated fragment becomes a roadbed without rails, and impulse traffic ceases.

To restore traffic, new conductor lines must be laid. This is done by the proximal fiber stumps rooted in the central cells. Their tips begin to move forward, and as they grow, the stump is spun out to greater and greater length; the fiber regenerates. Here, then, are the threads to reweave the torn fabric of nerve connections; can they be guided into a useful pattern instead of a chaotic tangle? They can with our help.

The deserted tubes of the disconnected distal end make good conduits for growing nerve sprouts. The problem is to direct the fibers into those conduits. The greater the gap between the stumps, the more pathless distance the fibers will have to span. How do they do it? It has been contended that nerve fibers are attracted toward their destinations by chemical emanations or electric forces. They are neither one nor the other. Their only

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\* From an illustrated address before the Senior High School Group of the Central Association of Science and Mathematics Teachers, November 27. Also broadcast over the CBS system on its "Adventures in Science" program.

guide is contact with surrounding structures to which they cling like climbing vines. This fact has been revealed and firmly established by experiments which I have carried out since 1927, using the method of tissue culture which was devised for just such purposes by Harrison more than thirty years ago. I demonstrated that tension applied to a colloidal culture medium will produce an oriented fibrous structure, and that cells and nerve fibers growing in such a medium will then follow the fibrous pathways along the lines of stress. In an unoriented medium, growth runs wild and ends up in a tangle.

Nerve surgery aims at channeling the nerve stream from the proximal into the distal stump. However, scar tissue tends to form between the stumps, and this tends to deflect and obstruct the outgrowing fibers. Even sewing the nerve ends together does not prevent the confusion and dissipation of fiber growth at the suture line.

It is at this point that the lessons of our earlier experiments on nerve growth become applicable. Heeding those lessons, I have arrived at a method which insures superior and unimpeded nerve regeneration in experimental animals. It consists of joining the severed nerve ends inside a fitting cuff of live artery. The elasticity of the link permits tension to be transmitted to the tissue filling the gap so as to produce in it straight and direct rails for the transit of nerve fibers and cells from one stump to the other. Moreover, it shuts the fibers in and scar tissue out. At the end of several months, nerves thus united show hardly any trace of the former damage. However, the method has yet to stand its clinical test. Until then, its value for human nerve repair remains problematical. So much about the reunion of nerves after mere severance.

The bridging of larger nerve defects offers more serious difficulties. As we have said before, the best pipelines for nerve growth are the deserted tubes of a disconnected nerve. The insertion of such nerve segments into large gaps, a method known as "nerve grafting," has, therefore, been practiced with some success. One of the main problems, however, is where to get a piece of nerve for the purpose without sacrificing some good nerve to repair a bad one. Past attempts at using animal nerves or human nerves from amputations after preservation in alcohol or formaldehyde proved wholly unsuccessful. Such grafts turn into tough cords practically impervious to nerve growth. Some recent experiments of our laboratory seem to point a way out of the dilemma. With the assistance of my former student,

Dr. A. Cecil Taylor, I tested the effect of quick-freezing and drying on nerves. It turned out that such nerves, when reimbibed and used as grafts, served excellently as conduits for regenerating nerve fibers. Again, our results are thus far confined to animals. But if the method could be adapted for clinical use, it would solve the supply problem of nerve grafting. For, nerves of amputated limbs, which would otherwise be discarded, could be frozen, dried and stored in this condition for later use as grafts.

These are only samples of the many efforts currently under way, striving for improvement in nerve repair. Fortunately, these efforts can proceed from a much firmer foundation of knowledge about nerve growth than was available during the last war. It is gratifying that our years of prying into the mechanism of nerve growth may benefit the practice of nerve repair. But, to be honest, this was not our primary objective when we started our research. We were simply interested, purely scientifically, in what makes nerves grow and how and why; not just human nerves; any nerves, frog and chick and rat. Such basic knowledge furnishes the keys for practical applications as surely as trees bear fruit. But you cannot raise fruits by short cuts. You have to raise the tree. You have to make the tree of knowledge grow *as a whole* in order that in due course you may reap the fruits that will benefit your health, security and comfort. I think the story I have told you illustrates the point.

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#### BETTER MECHANICAL REFRIGERATORS EXPECTED AFTER WAR

"More goods, better goods, for more and more people at constantly lower and lower prices," is the slogan of the mechanical household refrigeration industry, declared H. L. Andrews of the General Electric Company, at the meeting of the American Society of Refrigerating Engineers. An estimated total of 20,000,000 mechanical refrigerators are in use today in 65% of the wired and gas-served homes in America, he stated.

After the war an annual sale of from three to four million refrigerators is expected by the refrigerator industry. Many will be replacements. Others will be due to the extension of electric lines in rural areas to farm homes. Still others will be to new families, to old urban and suburban homes recently wired, and to a developing export trade.

Two-temperature models of mechanical refrigerators will replace present models, he predicted. "New motors and new compressors of improved efficiency will unquestionably be available; new refrigerants to fit these compressors; new evaporator designs; new condensers; new and more reliable thermostatic controls; new insulation; new cabinet designs are all well within the grasp of the design engineers and the factories."

Mr. Andrews predicted a rapid expansion in home air-conditioning also. Figures, he said, show "that the considerable increase in demand for residential air conditioning in 1940 and 1941 indicates a very promising future growth in that field."

## A NEW APPROACH TO TEACHING ARITHMETIC IN THE UPPER GRADES\*

THEODORE W. ANDERSON

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It was felt that an exchange of ideas in the field of verbal problems and methods used by the teachers in special schools and those who send us our pupils should be wholesome.

I must admit that I am prejudiced in favor of the type of boy that you are prejudiced against. The type of boy that we have at the Montefiore Special School is the "delinquent and incorrigible" type, who does not look into the future but rather looks to the present for immediate results. He doesn't have much academic background and generally his educational achievement exceeds that of his parents and other members of his family. He seems to be satisfied with this situation and he is not eager to continue his scholastic training. Therefore, it is a challenge to me to work with this non-academic boy for it affords another opportunity to explore new relationships; another opportunity to change his outlook on life and what it holds for him.

Every child has problems and inevitably some are mathematical in nature. The printed page is a means of helping him to solve his problems, and reading is a tool which helps him to do this. It not only involves the recognition of the printed symbols, but also a recognition of the meanings of these symbols. Hence, reading is not an end in itself but rather a means toward an end, whereby the pupil will gradually become free and self reliant by learning to depend upon himself.

The war has brought our attention to the fact that America is a nation of poor readers—many members of our armed forces are unable to read and follow instructions and directions with understanding, and more than half the Army and Navy officer applicants regularly "flunk" the tests for mathematical aptitude. As content-subject teachers it is our duty to give the pupil instruction in reading in addition to that which he receives from the English or reading teacher. In the "war mathematics" that we are stressing at the present time many problems pertain to travel in air or on water. The teacher meets with many opportunities to improve the child's understanding and interest in

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reading and solving verbal problems. Reading and computation are interdependent in verbal problem solving; as there exists interdependence in every field of endeavor, so does arithmetic reasoning and computation travel hand in hand. That we cannot desert drill work and computation is true, but we cannot forget the fact that seventy-five per cent of the arithmetic that a man does in the world of industry and commerce is of the reasoning-computative type, rather than simply one of the two.

In the solution of a verbal problem the reading of it is important; hence, careful reading is necessary. It is the work-type of reading that we are interested in, where the emphasis is upon analysis and reflection rather than on enjoyment. The pupil must discover and understand the purpose for which he is reading; he must analyze and understand the conditions of the problem; he must determine "what is given" and "what is to be solved"; he must consider the suggestions of the writer for solutions to his problems; and he must decide what method of procedure is appropriate to the particular problem he is trying to solve. This must all be done before operations are attempted.

A child can learn to think through observation and discussion without the use of books, but if he is going to learn to use the thought of others he must be able to read. The teacher must reserve time in the class period for the reading of problems aloud. Interest and inspiration are contagious and should begin in the teacher.

Questions that a teacher could ask herself that would guide her in teaching verbal problems might be: "Does the pupil have an adequate mathematical vocabulary and does he mispronounce words, or does he understand the majority of the words? Does the child follow directions and does he get the main idea of the problem? Does the pupil know "what is given" and "what is to be solved," and does he understand the proper procedures—the steps necessary for the solution? Can the boy note the important details and can he come to some conclusion from his findings? Do the problems meet the child's needs and are they interesting to him?"

As the pupil reads the problem aloud he may encounter vocabulary difficulties and mispronunciation. This will necessitate dictionary consultation and discussion for clarification, and in turn the child's vocabulary is enlarged. The teacher and the pupil should make up a mathematical vocabulary—a technical vocabulary if you prefer. The pupil must not only know how to

pronounce the word but he must select the correct meaning of it in the particular setting that it is encountered. This situation that exists in the sixth grade continues from grade to grade and in the ninth grade the algebra pupil finds that a new type of vocabulary is necessary as well as an understanding of the symbols and their meanings, along with abbreviations, key words and signs.

The teacher can list a number of terms used in the work either on the blackboard or on mimeographed sheets, such as minuend, sum, divisor and others, and then ask the pupil to fill them in properly in problems set before him. By this means she can readily ascertain whether the child understands the meanings of these terms.

A similar extension of mathematical ideas which necessitates the use of the encyclopedia and other reference books should go along with vocabulary building. For instance, if the right triangle is being studied the boy may be assigned a written exercise to hand in, as "A Report on the Life of Pythagoras," where he will be asked to tell of Pythagoras' struggles and contributions to mathematics and science. Or it may be on some other personage, as Archimedes—or it may be on the "History of Land Surveying." It might be that the problems studied pertain to airships. If so, the child may be asked to write up what he can find on the particular plane mentioned in the problem. Another problem may concern cattle, or sheep, or hogs. Here he could hand in a paper on the Chicago Stock Yards—and so on. Also, we should encourage him to bring old books from home that may be of interest to the class and have bearing on the work. As teachers, we must train the child to read for a definite purpose, to look up difficult words, and to select the proper definitions of the words, and to organize and summarize the ideas that he has gathered.

There are a number of ways that the teacher can help train the child to answer questions and to follow directions. At first the directions given to him should be simple. These can be given orally by the teacher, or written on the board, or handed out in mimeographed form. These directions can even start with the heading of the paper, as to name, school, date, room number and so on. Then he can be given lessons in using the ruler, such as drawing lines in specified ways—as horizontal, vertical, diagonal and parallel lines, and geometric figures such as squares, rectangles and triangles. Vocabulary difficulties may present

themselves directly which will need discussion and illustrations, for the child may not know the meaning of 'vertical' or 'parallel.' The teacher and pupil can find many illustrations in the room.

Or, again, the child can be given exercises in the use of the compass by drawing circles of different sizes. Here he meets up with such terms as center, radius, diameter, circumference and arc to add to his vocabulary. The protractor can be introduced to him and the circle can be divided into different parts.

Graphs can be discussed and drawn for practice in learning to take directions. The boy should be given much practice in making graphs and should understand the advantage of the different types of graphs and when each should be used—for instance, the line graph may show the daily earnings of one, or the pupil's grades over a certain period of time; the bar graph is best suited to show two or more relative sizes, as mountains, areas, or populations; and the circle graph is best used for showing the parts of a whole, such as "how the boy spends the twenty-four-hours of his day" or "how he spends his weekly earnings," and the like. He can be given many interesting exercises in graphs on the School Children's Aid collection, or the Red Cross Drive, or the sales of War Savings Stamps in the room or in the school, and any number of other projects.

Charts are valuable means in attaining a boy's interest in decimals and percentage. By filling out various business blanks and forms, as receipts and money orders he gains additional practice in how to follow directions.

Making scale drawings is another method to help the child learn to follow directions. He must be led to realize the impossibility of drawing everything to full size on a piece of paper. After he understands what scale drawings mean, how scales are used and decided upon, he can suggest objects to draw in the room, such as pictures, the top of the teacher's desk, the top of his own desk, the top and side of the filing cabinet, the window pane, the window frame, the floor of the room, the floors at home, the school playground—and many other objects. This will also give him practice in measuring and in determining the scales to be used. The teacher must bring the pupil fully into the discussion in determining what to do in different situations.

When he can follow directions the teacher will wish to know if the boy gets the main idea of a problem—if he understands what steps are necessary and how to perform these steps, and if he knows "what is given" and "what must be found." As

teachers, we must teach him definitely how to work and what to study instead of just assigning a set of problems to him with no directions or hints as to how they are to be solved. If we help the boy to discover his weaknesses, whether they be due to lack of experience or mechanical difficulties, he will improve his ability to recognize, analyze, associate, and draw conclusions.

One device which is valuable in training the maladjusted and non-mathematically inclined pupil to solve verbal problems is to have the group discuss and help to decide upon the solution. The brighter pupil, especially, will contribute to the solution, while the slower one, as he listens and observes, is greatly aided in understanding and recognizing the problem situation. Problems of all sorts should be read aloud for understanding and oral solution, for the processes should be visualized and not worked out on paper at first. Some pupil is asked to read the problem—the teacher then might ask pupil A to tell “what is given”—Pupil B is called upon to tell “what must be found.” Pupil C is asked to tell the first step that must be taken—Pupil D tells what the second step should be—another pupil can explain the third step to be taken, if there is one, and so on. Then the teacher calls upon another child to tell the others *how* the first step is performed—another pupil explains *how* to work the second step—and still another tells *how* to do the third step, and so on through the steps. When the class has coöperatively suggested how to solve the problem, then someone can estimate the answer. This gives the pupil practice in estimating. Another child can tell the group how the answer may be tested for accuracy.

After the child has had practice in visualizing the solution he may solve the problems with pencil and paper. It is well, at first, to have him write out what is “given” and what there remains “to find.” This is good practice, until the habit becomes firmly established in his mind; so that he is gradually trained to work with a purpose in view, and so that he does not plunge directly into the heart of a problem, and get lost in a maze of confusion. He must be clear on where he is starting from and where he must travel to attain the goal.

As the sixth grade boy must analyze and interpret his problem, so too must the eighth and ninth grade boy do likewise. In an exercise as:

“If six is added to the second number, it will be equal to the first number,” we note that interpretation is necessary of the problem and its symbolism. Then the boy must match the

verbal directions with the correct step in the computation; and then he must follow the correct order in the computation. He must also select the "known" from the "unknown," and he must detect the essential relationships from the non-essential relationships. Then he must translate this material into symbolism and then set up the equation.

There are numerous ways in which the boy can be helped to know the meanings of the terms and to recognize the processes necessary for a solution to the problem. He can be given exercises in filling in words or groups of words in statements, as:

"In the fraction  $\frac{3}{5}$ , 3 is called the \_\_\_\_\_, and 5 is called the \_\_\_\_\_."

Or,

" $\frac{3}{4}$  is called a \_\_\_\_\_ fraction."

".25 is called a \_\_\_\_\_ fraction."

or,

" $\frac{5}{8}$  and  $\frac{5}{8}$  have the same \_\_\_\_\_."

The teacher might also give him exercises, as:

20	$2 = 18$	15	$3 = 5$
3	$2 = 5$	16	$4 = 4$

and ask the boy to place the correct symbol, such as  $+$ ,  $-$ ,  $\times$ , or  $\div$  in the proper place. He gets practice in this manner in knowing the processes necessary for the solution.

Another means to have the pupil understand the meanings of the terms and processes necessary is to have him select the correct answer or definition of a term from a number of statements given, as:

"The sum means:

The answer I get in subtraction.

To multiply one number by another number.

The answer I obtain in addition."

This can be carried out for all terms that have been considered, up to date.

Our ninth grade pupil must understand such terms as, "less than, greater than, increases, decreases, exceeds, rate, distance, area," and many others. He must understand the meanings of "powers and roots"; he must understand that the  $\div$  sign means the same as a fraction, as,  $\frac{3}{4}$  means  $3 \div 4$ ; he must understand that  $5n$  means 5 times the number of pounds; and that  $n/2$  means  $\frac{1}{2}$  of the number of pounds. All these and many others need much discussion, illustration, and practice.

If we can determine a child's interest, we have a key to the methods necessary to help him to solve verbal problems. Arithmetic was never meant to be all pleasure and no pain, but we must agree that if arithmetic is made genuinely interesting to the pupils that greater learning and retention will be the result. While we are compelled to make the problems interesting, we must always remember to use a simple vocabulary and terms that the pupil understands. Most failures in and dislike for mathematics have arisen because of lack in understanding the problems and how to solve them so the emphasis should not only be on skills, but rather on understanding, appreciation, habits and attitudes.

A "sore spot" might be the subject matter or the manner in which the verbal problem is presented in some of the textbooks. It seems that the child's interests have been neglected in wording arithmetic thought problems. At best, it is difficult to gain a pupil's interest in arithmetic, so we will gain much if we appeal to his interests. For instance, a problem such as:

"A farmer's wife bought  $2\frac{1}{2}$  yards of table linen at 80 cents per yard, and 16 yards of flannel at 55 cents per yard. She paid her bill in pounds of butter at 50 cents per pound. How many pounds of butter did she give in exchange?" This problem would not especially enthrall an urban boy. But if we change this problem to read:

"A member of the Aeroplane Club bought a  $16\frac{1}{2}$  inch block of balsa wood at 50 cents per square foot, and 3 square feet of model airplane paper at 5 cents per square foot. He paid the bill in labor at 20 cents per hour. How many hours did he work in exchange?"—we would discover that the subject matter appeals to him.

We should remember to keep the contents of the problem interesting in situations familiar to the boy and state the problem so that it is easily visualized.

Another problem states:

"What is the volume of a rectangular tank which is 6 feet long, 3 feet wide, and  $2\frac{1}{2}$  feet deep?"

The pupil will be much more concerned if we ask him to bring to class the dimensions of his fish aquarium at home, or if he is sent to the science room to measure the aquarium in that room, or ask him to find the dimensions of the swimming tank at school or the pool in the park. His interest is awakened and he will be anxious to find out how much water these contain.

Still another problem reads:

"A farmer raised 25 tons of hay on a  $7\frac{1}{2}$  acre field. Find the average value of the yield per acre if the hay sold at 18 dollars per ton."

A city boy may not be interested a great deal in such a problem, but if we present it in another form as:

"John's mother works  $5\frac{1}{2}$  days per week in an office at 30 dollars per week, and his father works in a store earning 40 dollars per week for the same number of days. What is their combined daily wage? How much will they earn this month?"—he will be interested for it has to do with the family budget.

As we introduce "ratio" in the sixth grade a boy may not be interested in comparing the speed of a man with the speed of a horse, nor in comparing the speed of a horse with the speed of an automobile; but if we ask him to compare the speed of a Cub Trainer plane with the speed of a Flying Fortress his interest is assured for the entire class period.

Every sixth grade text has problems on rainfall in connection with the addition and subtraction of decimals, in finding averages, or in graph work. Hardly any child in Chicago is interested in comparing the rainfall of Mobile, Alabama with that of Phoenix, Arizona; but if he is given a problem in the form that one of the factors to determine whether Chicago has a lake-front airport, or a Cicero Avenue airport is based on weather conditions, much research would follow and decimals would be important in its solution and drawing the necessary conclusions.

The sports pages of our daily papers offer excellent opportunities to teach decimals and percentage in an interesting manner to the boy—the league standings, for instance.

Perhaps he is interested in vocational or manual subjects. Then his verbal problems should "tie-up" with his shop work. If his interests lie in the field of science, or geography, his verbal problems should relate to these fields. The main object is to make the problems real to him. That does not mean that they must be limited to marbles or grocery purchases, for often imaginary situations may be clearly comprehended and appear real to the child, as problems based on common business procedures. Just so they are not unusual procedures in industries unknown to the child. The problems should, of course, constantly reflect the practices of commerce and industry.

We are eager to develop good habits in "Johnny," such as attention to his work. If we adapt his verbal problems to his

needs and interests, and if he is given something definite to work out, and if we do not only attempt to deal with technical matters and skills, then we will have his attention. He asks himself and sometimes he asks us, "Is this worth while? When will I use this?" He wonders if what he is learning will mean something to him today, tomorrow, or later in life—or is his problem solving just another "must" to him?

I have emphasized the value of making the problems real and interesting in order to help the boy form good habits, because in dealing with the boy who has had misfortunes in his school life or home life it is more pertinent than ever that we do this. Our boys at the Montefiore School are of this type.

The reading of a problem is an interpretation of the statement or question. It is ascertaining, considering and translating its contents. Reading is also perceiving and apprehending the meanings of any signs and marks. Therefore, any difficulty that interferes with the interpretation of a problem is a reading difficulty.

In conclusion may I suggest that oral reading of verbal problems in class should be done at least once or twice a week, for the pupil needs much practice and training in reading. It is said that a good teacher needs no textbook, but the pupil will have to know how to read, as he continues to advance in his school work or in life. We hear much today about freedom for the peoples of the earth, but let us, as content-subject teachers, help to unshackle our youth from the bondage of poor reading and understanding by showing him how to read, how to study and how to work. Allow him to have an active part in finding the proper solutions to his problems, for by this coöperation we help to train him for society and good citizenship.

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## NOTES FROM A MATHEMATICS CLASSROOM

JOSEPH A. NYBERG

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*(Continued from the December issue)*

**62. The Meaning of Algebra.** Near the end of the year I ask the ninth grade algebra class to prepare a summary of the work. I do not want an outline of the chapters but an answer to the questions: *What is Algebra?* How does it differ from arithmetic? What new mathematical ideas have we been studying? The pupils express their ideas for five or ten minutes on three or four days, and then reports are written, criticized in class, and finally each pupil writes an essay on the subject. Some of these are presented in class—not read, but presented as a project in public speaking. “It is my great pleasure to present this afternoon John Jones, one of our foremost scholars, who will talk to us on the subject *What Algebra Means to Me.*”

If Jones is a bright pupil he may speak as follows: “Dear Teacher and Fellow Pupils: I shall explain the meaning of algebra under seven headings.

One. Algebra uses negative numbers. They are used to show the changes in a quantity, a negative change being a decrease and a positive change an increase. Negative numbers save work when finding averages of numbers. They reduce the number of rules and formulas that must be learned. They also simplify the work of solving equations.

Two. Formulas are merely rules written in mathematical symbols. A formula can be used not only to find the value of the quantity mentioned in the left member but also to find any quantity mentioned in the right member provided that we know all the quantities in the formula except one. The subject of a formula can be changed so as to express any one of the quantities in terms of the others.

A formula states the relation between various quantities, telling how one of them depends on the others. This dependence can be shown by making a table of corresponding values, and from the table we can draw a table to show the dependence. The main business of mathematics is to study the relations between quantities, and to express these relations in simple language.

Three. A graph is a picture showing how one quantity depends on another. If one of the variables is *time* then the graph

shows the state of affairs not only at one particular moment but at *any* moment. A graph always solves two kinds of problems; if the quantities are  $x$  and  $y$ , the graph can be used to find the value of  $y$  for any  $x$ , and to find the value of  $x$  for any  $y$ . The word *any* is important because in arithmetic we solve one problem at a time while in algebra we solve many problems at once.

Four. We have studied four kinds of equations: linear equations, sets of equations, quadratic equations, and literal or general equations. There are two ways of solving sets of equations and three ways of solving quadratic equations. Quadratic equations are peculiar because they have two answers. Literal equations are the most important because they are needed to solve general problems.

Five. In any problem we are given certain information called the *data*. Certain quantities are unknown and these we are to find. The steps in solving a problem are:

- (a) Know what is the data and what is wanted.
- (b) Express the unknowns in algebraic language.
- (c) Find some relation between the numbers that can be written as an equation or a set of equations.
- (d) Solve the equations. To do this you will need to be skillful with fractions, parentheses, multiplication, factoring and other operations.
- (e) Check the answer to see if it fits the problem.

Six. To write the equations in the third step of solving problems we must know such relations as

distance traveled = average speed  $\times$  time,

selling price = cost + profit,

per cent of error = error  $\div$  correct value,

interest = principal  $\times$  rate  $\times$  number of years,

amount of work done = amount of work done in one hour  
 $\times$  the number of hours worked,

work done by one machine + work done by another machine  
 = total work done,

amount of fat, acid, metal in one mixture + amount of fat,  
 acid, metal, etc., in another mixture = the total amount of  
 that material in the combined mixtures.

These are merely examples of dozens of relations that we use to solve problems. Most of them are as simple as saying that the cost of some butter and the cost of some eggs is the cost of the butter and eggs. The strange thing about them is that when stated in English they sound childish but when written as an equation they can solve problems.

Seven. In arithmetic, when we solve a problem, we solve that one problem. But in algebra we try to solve many problems at once. This is done by generalizing the problem. To generalize a problem we substitute general numbers for the specific numbers in the data. Generalizing a problem is valuable because it gives us a formula for solving all problems of one kind. And when we generalize a problem we may discover new relations. Generalizing is the main business of algebra."

Once, many years ago, there was a decidedly exceptional pupil in the class. He became a playwright; Broadway and London have seen his plays. He ended his summary with some remarks about as follows, as I remember them:

"Mathematicians are peculiar people. They seldom do what you expect them to do, often appear to do the wrong thing, but usually get the right answer. When a mathematician writes  $2x+3$  you would expect him to add 3 to  $2x$ , but he is more likely to subtract 3 instead. He seldom does what he is told to do; he merely writes what he intends to do, and then seeks ways to avoid the work. But he gets the answer. He also likes to reverse a problem. If I say I have four nickels and three dimes, we all know how much money I have. But a mathematician likes to tell how many nickels and dimes I must have when I tell him how much money I have. Mathematicians are peculiar people."

63. Solving  $a \cos \theta + b \sin \theta = c$ . Only a few high school classes study this equation, except in simple cases, but the following notes may interest mathematics clubs.

The equation should first be treated in the usual way: express the functions in terms of one function, transpose so that the irrational term is alone, and then square both members. There will be four roots, and the extraneous ones must be found. The fact that extraneous roots always exist is a good reason for studying the equation.

I like to point out that mathematicians dislike squaring both members of an equation and therefore seek other methods. Hence we substitute  $r \sin A$  for  $a$ , and  $r \cos A$  for  $b$ , and reduce the equation to the form  $\sin(\theta + A) = k_1$ .

There are three other substitutions possible. We can, for example, use  $r \cos B$  for  $a$  and  $r \sin B$  for  $b$ ; or we can use  $r \sin A$  for  $a$ , and  $-r \cos A$  for  $b$ . These substitutions lead to equations like

$$\cos(\theta - B) = k_2 \qquad \sin(\theta - A) = k_3 \qquad \cos(\theta + B) = k_4$$

Much can be learned by dividing the class into four groups and having the four substitutions compared.

A geometric solution which I have not seen in any text is as follows:

Using an  $x$  and  $y$  axis, draw the circle whose diameter is the line from the origin to the point  $(a, b)$ . The method is good whether  $a$  and  $b$  are positive or negative. Also draw the circle with center at the origin and the radius  $c$ . Then the lines from the origin to the intersection points of the two circles determine, with the  $x$  axis, the desired angles.

The geometric solution is interesting because it shows the angles  $A$  and  $B$  which were used in the algebraic solutions. The figure also shows why there is no solution if  $c^2$  is greater than  $a^2 + b^2$ . The figure also eliminates the extraneous roots quickly since it selects the two correct roots. I assign as an "extra" problem that of proving the geometric method; over a period of many years few pupils have done so. It is easy, of course, if polar coordinates have been studied. Another "extra" problem is that of finding in the figure the extraneous roots; they should be there since every algebraic step has its geometric explanation.

Before introducing the geometric method I have often entertained the class by saying that I can solve mentally in thirty seconds any equation of this form (with coefficients less than 10), eliminate the extraneous roots, state in which quadrants the correct solutions will be, and estimate the roots within five degrees.

The method is simple. The circle whose diameter is the line from  $(0, 0)$  to  $(a, b)$  passes through the corners of the rectangle whose other vertices are  $(a, 0)$  and  $(0, b)$ . Mentally I sketch this rectangle and circle, and the circle whose center is the origin and radius is  $c$ . The intersections of the two circles are easily visualized. Then I estimate the angles. Naturally the pupils challenge my statement and try to make the problem difficult by using the numbers 8, 9, and 10. And I am prepared—in fact I know the solutions within a degree—from past experience.

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### PHYSICAL FITNESS IN AMERICAN COLLEGES

War conditions are improving the physical fitness of American college men. The Department of Physical Education, Syracuse University, has released indices which show that men enrolled this year score an average physical fitness index of 114.2, compared with 91.1 a year ago.

## RELIABLE BOOKS ON POST-WAR PROBLEMS

HARL R. DOUGLASS

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This is the time of course when schools should be laying the foundations for intelligent public attitudes upon the great problems with which we will be faced in the next twenty-five years, namely, (1) those having to do with national economic reorganization; and (2) those having to do with the international relationships and peace. Those who waged the battle for free public schools had in mind such a purpose, as is indicated by hundreds of statements that have been made by our presidents and national leaders from George Washington on down.

"Promote then, as an object of primary importance, institutions for the general diffusion of knowledge. In proportion as the structure of a government gives force to public opinion, it is essential that public opinion should be enlightened." (George Washington in his Farewell Address.)

"Education is more indispensable, and must be more general, under a free government than any other. In a monarchy, the few who are likely to govern must have some education, but the common people must be kept in ignorance; in an aristocracy, the nobles should be educated, but here it is even more necessary that the common people should be ignorant; but in a free government knowledge must be general, and ought to be universal." (John Q. Adams)

The teacher or administrator today who is not reading widely and intensively in these areas is hardly capable of preparing young people for the world in which they will live. They are schoolmarms and schoolmasters rather than modern educators. Failing to keep informed and oriented in these areas is inexcusable in the light of the large number of short, readable, reliable books and pamphlets that are available.

Below is a short list of selected books and pamphlets illustrative of this thought. Failing to keep informed and oriented in these areas is inexcusable in the light of the large number of short, readable, reliable books and pamphlets that are available.

### I. SHORT NON-TECHNICAL RELIABLE BOOKS ON POST-WAR PROBLEMS

Agar, Herbert, *A Time for Greatness*, New York, Simon and Schuster, 1943.

Chase, Stuart (1941-42), *Goals for America; The Road We Are Traveling*;

- The Dollar Dilemma; Tomorrow's Trade; Farmer, Worker, Businessman; and Winning the Peace. Six small dollar monographs. Twentieth Century Fund, New York City.
- Davies, Joseph, *Mission to Moscow*, New York, Simon and Schuster, 1941.
- Hoover, Herbert and Gibson, Hugh, *The Problems of a Lasting Peace*, Garden City, N. Y., Doubleday, Doran, 1942.
- Hindus, Maurice, *Mother Russia*, New York, Doubleday, Doran, 1942.
- Lippmann, Walter, *American Foreign Policy*, Boston, Little, Brown & Company, 1942.
- Marshall, James, *The Freedom to Be Free*, New York, John Day Company, 1943.
- Motherwell, Hiram, *The Peace We Fight For*, Harper and Brothers, 1943.
- Motherwell, Hiram, *Rebuilding Europe After Victory*, Public Affairs Pamphlet No. 81, Public Affairs Committee, New York, 1943. 10¢ Pp. 32.
- Rugg, Harold O., *Now Is the Moment*, Houghton, Mifflin, 1943.
- Wallace, Henry, *The Price of Free World Victory*, New York, Fisher, 1942.
- Wallace, Henry, *The Century of the Common Man*, New York, Reynal and Hitchcock.
- Willkie, Wendell, *One World*, New York, Simon and Schuster, 1942.
- Willkie, Hoover, Gibson, Wallace, Welles, *Prefaces to Peace*, New York. Book of the Month Club. Symposium: One World, Problems of Lasting Peace, Price of Free World Victory, Blueprints for Peace.
- Yutang, Lin. *Between Tears and Laughter*, John Day Co., New York, N.Y.

## II. PAMPHLETS AND PERIODICAL ARTICLES

### Post-War Economic and Social Problems

- Hansen, Alvin H., "After the War—Full Employment," *National Resources Planning Board*, January, 1924.
- Bailey, Thomas A. *America's Foreign Policies, Past and Present*. Headline Books, No. 40. The Foreign Policy Association: New York, 1943, 25¢. Pp. 96.
- Dean, Vera Micheles, *The Struggle for World Order*, Headline Books, No. 32, The Foreign Policy Association, New York, 1941, 25¢. Pp. 96.
- Educational Policies Commission, *Education and the People's Peace*. National Education Association of the United States: Washington, D.C., 1943, 10¢, Pp. 59.
- National Resources Planning Board, *After the War—Toward Security*. Washington, D.C., Superintendent of Documents, 1942.
- The United States in a New World*. A Study and Discussion Outline and reprints of very splendid reports: I, Relations with Britain; II, Pacific Relations; III, The Domestic Economy; IV, Relations with Europe; V, Our Form of Government. By the Editors of *Time*, *Life* and *Fortune*. Bureau of Special Services, 9 Rockefeller Plaza, New York City.

## THE NEW JAP RIFLE

Japan's new infantry rifle, captured specimens of which have been received at the War Department here, may be an advance over the nearly 40-year-old .25-caliber model it supersedes, but it is still far behind the Garand with which American forces are armed. The new Japanese weapon is of the same caliber as the British Enfield, .303 inches; thus larger by a split hair's-breadth than the American .30 caliber small-arms. This gives the bullet better ballistic properties at medium and long ranges than the too-light .25-caliber projectile. However, the tests indicate that the Jap rifle's accuracy is not dependable at ranges of more than 350 yards.

## PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

*State Teachers College, Kirksville, Mo.*

*This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.*

*All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem, sent to the Editor should have the author's name introducing the problem or solution as on the following pages.*

*The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.*

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### SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.
2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.
3. In general when several solutions are correct, the one submitted in the best form will be used.

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### LATE SOLUTIONS

1828. *Walter R. Warne, Fayette, Mo.*

1834. *Marcellus M. Dreiling, Collegeville, Ind.*

1825, 6, 36. *Osiias Bain and Wallace Beardsell, Quebec, Canada.*

1830. *Adrian Struyk, Paterson, N. J.*

1837. *Proposed by J. Frank Arena, Hardin, Ill.*

Solve for  $x$ :

$$\sqrt[3]{a-x} + \sqrt[3]{b-x} = \sqrt[3]{a+b-2x}.$$

*Solution by Paul D. Thomas, Great Lakes, Ill.*

Let  $A = a - x$ ,  $B = b - x$ . The equation may then be written

$$A^{1/3} + B^{1/3} = (A+B)^{1/3}.$$

Cubing both sides,

$$A + 3A^{2/3}B^{1/3} + 3A^{1/3}B^{2/3} + B = A + B, \text{ or}$$

$$A^{1/3}B^{1/3}(A^{1/3} + B^{1/3}) = 0.$$

This gives

$$A=0, B=0, A=-B, \text{ or } x=a, x=b, x=\frac{a+b}{2}.$$

Solutions were also offered by David Rappaport, Chicago; Adrian Struyk, Paterson, N. J.; Gordon Duvall, Cincinnati, Ohio; R. Mansfield,

Chicago; C. E. Jenkins, Chicago; Alan Wayne, New York; Margaret Joseph, Milwaukee, Wis.; Walter R. Warne, Fayette, Mo.; M. Kirk, West Chester, Pa.; Hugo Brandt, Chicago; Marcellus M. Dreiling, Collegeville, Ind.; Richard W. Franbel, Camp Crowder, Mo.; J. Frank Arena, Marion, Ill.

**1838. Editor's Apology.** J. Frank Arena writes that he did not propose this problem. It appeared in April 1943 issue. However credit is given to the following names of people for sending in solutions.

Hugo Brandt, Chicago; Marcellus M. Dreiling, Collegeville, Ind.; Milton Brooks, Philadelphia, Pa.; Helen M. Scott, Baltimore, Md.; M. Freed, Wilmington, Calif.; Walter R. Warne, Fayette, Mo.; Clyde A. Bridger, Salt Lake City, Utah; M. Kirk, West Chester, Pa.; H. D. Hatch, Boston, Mass.; Melissa Brown, Jacksonville, N. Y.; Gordon Duvall, Cincinnati, Ohio.

**1839. Proposed by Alfred Seeley, Hoyt's Corners, N. Y.**

If  $x = c \tan \theta$ , show that  $(x^2 + c^2)^2 \sin 4\theta = 4cx(c^2 - x^2)$ .

*Solution by Marcellus M. Dreiling, Collegeville, Ind.*

$(x^2 + c^2)^2 \sin 4\theta = (x^2 + c^2)^2 4 \sin \theta \cos \theta (\cos^2 \theta - \sin^2 \theta)$ , and with  $\tan \theta = x/c$ , we have

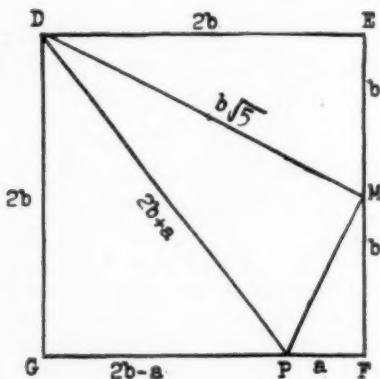
$$(x^2 + c^2)^2 \frac{4x}{\sqrt{x^2 + c^2}} \cdot \frac{c}{\sqrt{x^2 + c^2}} \cdot \frac{(c^2 - x^2)}{x^2 + c^2} = 4cx(c^2 - x^2).$$

Solutions were also offered by Adrian Struyk, Paterson, N. J.; Milton Brooks, Philadelphia, Pa.; Alan Wayne, New York City; Morris I. Chernofsky, New York City; Hugo Brandt, Chicago; David Rappaport, Chicago; Gordon Duvall, Cincinnati, Ohio; R. Mansfield, Chicago; Alfred Kronk, Hudson, N. Y.; Julia Marsh, Ann Arbor, Mich.; Paul D. Thomas, Great Lakes, Ill.; M. Kirk, West Chester, Pa.; D. F. Wallace, St. Paul, Minn.; Walter R. Warne, Fayette, Mo.

**1840. Proposed by Sadie Peck, Detroit, Mich.**

If  $P$  is a point in the side  $GF$  of square  $DEFG$ , such that  $DP = FP + FE$ , prove that the line from  $D$  to  $M$ , the midpoint of  $EF$ , bisects angle  $PDE$ .

*Solution by Sister Mary Paula, S.S.N.D., Baltimore, Md.*



*Solution*

Let the sides of the square be  $2b$  units in length, and the segment  $PF$   $a$  units. In right triangle  $DGP$ :

$$4b^2 + 4b^2 - 4ab + a^2 = 4b^2 + 4ab + a^2$$

and hence

$$4b^2 = 8ab \quad \text{or} \quad b = 2a.$$

Substituting  $2a$  for  $b$  in triangles  $DEM$  and  $DMP$ , the following values and relations are evident:

$$DE = 4a, \quad DM = 2a\sqrt{5}, \quad MP = a\sqrt{5}, \quad DM = 2a\sqrt{5}, \quad DP = 5a.$$

Also

$$DE:DM = EM:MP = DM:DP = \frac{2}{\sqrt{5}}.$$

Therefore triangle  $DEM$  is similar to triangle  $DMP$ , and hence angle  $MDE$  equals angle  $PDM$ .

Solutions were also offered by Milton Brooks, Philadelphia, Pa.; Morris I. Chernofsky, New York City; Hugo Brandt, Chicago; Marcellus M. Dreiling, Collegeville, Ind.; Helen M. Scott, Baltimore, Md.; Mildred Potter, Syracuse, N. Y.; Steven Ball, Adrian, Mich.; C. B. Breedlove, Detroit, Mich.; Gordon Duvall, Cincinnati, Ohio; Catherine Allen, Hartford, Conn.; Abbie Bryant, Spokane, Wash.; Paul D. Thomas, Great Lakes, Ill.; Walter R. Warne, Fayette, Mo. Moria Brown, Brittain, Mich. Margaret W. Laboyteaux, Morencie, Mich.; Edith M. Warne, Fayette, Mo.; F. D. Wallace, St. Paul, Minn.; M. Kirk, West Chester, Pa.; Adrian Struyk, Paterson, N. J.; M. Freed, Wilmington, Calif. and the proposer.

1841. *Proposed by G. E. Speer, Lodi, N. Y.*

Show that the length of an arc of the parabola  $y^2 = 4ax$ , which is intercepted between the points of intersection of the parabola and  $3y = 8x$  is  $a(\log 2 + 15/16)$ .

*First Solution by Paul D. Thomas, Great Lakes, Ill.*

The required arc length may be expressed;

$$\begin{aligned} s &= \int_0^{3a/2} \sqrt{1 + \frac{y^2}{4a^2}} dy = 2a \int_0^{\tan^{-1} 3/4} \sec^2 \theta d\theta \\ &= a [\log (\sec \theta + \tan \theta) + \sin \theta \sec^2 \theta]_0^{\tan^{-1} 3/4} \\ &= a(\log 2 + 15/16) \end{aligned}$$

as required.

*Second Solution by Gordon Duvall, Cincinnati, Ohio*

$$\begin{aligned} \frac{1}{2a} \int_0^{3a/2} (4a^2 + y^2)^{1/2} dy &= \frac{1}{4a} [y\sqrt{4a^2 + y^2} + 4a^2 \log (y + \sqrt{4a^2 + y^2})]_0^{3a/2} \\ &= \frac{1}{4a} \left( \frac{15a^2}{4} + 4a^2 \log 4a - 4a^2 \log 2a \right) \\ &= \frac{1}{4a} \left( \frac{15a^2}{4} + 4a^2 \log 2 + 4a^2 \log 2a - 4a^2 \log 2a \right) \end{aligned}$$

$$= \frac{15a}{16} + a \log 2 = a \left( \frac{15}{16} + \log 2 \right).$$

Other solutions were offered by Alan Wayne, New York City; C. E. Jenkins, Chicago; Walter R. Warne, Fayette, Mo.; Adrian Struyk, Paterson, N. J.; M. Kirk, West Chester, Pa.; Ralph Mansfield, Chicago; Helen M. Scott, Baltimore, Md.; Hugo Brandt, Chicago; Marcellus M. Dreiling, Collegeville, Ind.; J. Frank Arena, Marion, Ill.; Charles P. Louthan, Cleveland, Ohio.

**1842.** *Proposed by L. W. Ayres, Adrian, Iowa*

Find the sum to infinity of

$$1 + \frac{2^3}{2!} + \frac{3^3}{3!} + \frac{4^3}{4!} + \dots$$

*Solution by A. J. Zanolar, Collegeville, Ind.*

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \dots$$

$$xe^x = x + \frac{x^2}{1} + \frac{x^3}{2!} + \frac{x^4}{3!} + \dots$$

$$d(xe^x) = (xe^x + e^x) = 1 + 2x + \frac{3x^2}{2!} + \frac{4x^3}{3!} + \frac{5x^4}{4!} + \dots$$

$$x(xe^x + e^x) = x + 2x^2 + \frac{3x^3}{2!} + \frac{4x^4}{3!} + \dots$$

$$d[x(xe^x + e^x)] = e^x(x^2 + 3x + 1) = 1 + 2^2x + \frac{3^2x^2}{2!} + \frac{4^2x^3}{3!} + \frac{5^2x^4}{4!} + \dots$$

$$= 1 + \frac{2^2x}{2!} + \frac{3^2x^2}{3!} + \frac{4^2x^3}{4!} + \frac{5^2x^4}{5!} + \dots$$

$$\text{When } x=1, \text{ we have } 5e = 1 + \frac{2^3}{2!} + \frac{3^3}{3!} + \frac{4^3}{4!} + \frac{5^3}{5!} + \dots = 13.5914 \dots$$

Solutions were also offered by Alan Wayne, New York City; and Hugo Brandt, Chicago.

### HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

**1836, 7, 1825, 6.** Osias Bain and Wallace Beardsell, Quebec, P. Q.; John Ryf, Winneconne, Wis.; Michael Arnaud, R. A. Dobson, J. Hillborn, A. J. S. Ryland and H. H. Waterman, Upper Canada College, Toronto.

**1838.** Michael Arand, R. A. Dobson, R. M. C. Harrison, A. J. S. Ryland, Upper Canada College; A. Sturton, Quebec, P. Q.; Austin Cooper, Toronto; Sheldon Kert, Toronto.

1839. M. O. Arnaud, L. A. Dobson, R. M. C. Harrison, W. M. Kilbourn, A. J. S. Ryland and H. H. Watermann, Upper Canada College;
1840. Lynn Zellmer, Winneconne, Wis.; Jacob L. Chernofsky, Brooklyn, N. Y.; Robert Obeler and Walter Arens, Lane Technical H. S. Chicago; Jim Ritchie, Harold Brown, Margery Griebeling and Corbin Washington, Lexington, Ohio; Douglass Perry, Phineas Banning H. S. Wilmington, Calif.; Oliver Newkirk, Des Moines, New Mexico; A. Sturton, Quebec H. S., Quebec, P. Q.

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### PROBLEMS FOR SOLUTION

1855. *Proposed by Hugo Brandt, Chicago, Ill.*

Solve for  $x$ :  $14(\sin \frac{1}{4} \arcsin x + \cos \frac{1}{4} \arcsin x) = 15$ .

1856. *Proposed by Nellie Shepson, Elmira, N. Y.*

Solve completely the system:

$$(x+y)(x^2+y^2) = \frac{40}{3}xy$$

$$(x^2+y^2)(x^4-y^4) = \frac{800}{9}x^2y^2$$

1857. *Proposed by Grace Ausley, Clifton Springs, N. Y.*

Prove:

$$\frac{2}{3}(\sqrt{3}+1)^2 - 2(\sqrt{2}+1)^2 = \sqrt{59-24\sqrt{6}}$$

1858. *Proposed by Hugo Brandt, Chicago, Ill.*

Solve for  $x$ :

$$e^{-x} = \sinh(x)$$

1859. *Proposed by Howard D. Grossman, New York City.*

Is there a formula for the sum of the angles of a skew quadrilateral?

1860. *Proposed by Helen M. Scott, Baltimore, Md.*

Four equal tangent spheres of radius  $r$ , are circumscribed by a sphere of radius  $R$ . Find  $R$  in terms of  $r$ .

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### BOOKS AND PAMPHLETS RECEIVED

NAVIGATION, by Lyman M. Kells, Ph.D., *Professor of Mathematics*; Willis F. Kern, *Associate Professor of Mathematics*; and James R. Bland, *Associate Professor of Mathematics*. All at the United States Naval Academy. Cloth. Pages xx+479. 15.5×22.5 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price \$3.75.

THE SCIENCE OF EXPLOSIVES, by Martin Meyer, *Professor and Chairman of the Department of Chemistry, Brooklyn College, and Consulting Chemist*. Cloth. Pages xi+452. 13×21.5 cm. 1943. Thomas Y. Crowell Company, 432 Fourth Avenue, New York, N. Y. Price \$4.50.

BASIC AIRCRAFT CONSTRUCTION, By Ross A. Peterson, *Director of Education*, and Raymond E. Erickson, *Supervisor of Education, North American*

*Aviation, Inc.*, Dallas Division. Cloth. Pages iv+204. 12.5×18.5 cm. 1943. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price \$2.00.

EARTH SCIENCE, by Gustav L. Fletcher, *Chairman, Department of Physical Science, James Monroe High School, New York City*. Revised Edition. Cloth. Pages vi+583. 13.5×20.5 cm. 1943. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price \$2.20.

WHAT TREE IS THAT? Books One and Two, by J. E. Potzger, Ph.D., *Department of Botany, Butler University, Indianapolis, Indiana*. Paper. 64 pages each. 21×27 cm. 1938. Kenworthy Educational Service, Buffalo, N. Y.

INSECTS AND SOME OF THEIR RELATIVES, by J. E. Potzger, Ph.D., *Department of Botany, Butler University, Indianapolis, Indiana*, and Margaret Esther Whitney, Ph.D., *Department of Biology, Central Normal College, Danville, Indiana*. Paper. 64 pages. 21×27 cm. 1943. Kenworthy Educational Service, Buffalo, N. Y.

BIRDS, Books One, Two, Three, by J. E. Potzger, Ph.D., *Department of Botany, Butler University, Indianapolis, Indiana*, and Gladys M. Friesner, M.A., *Teacher in the Indianapolis Schools*. Paper. 64 pages each. 21×27 cm. 1938. Kenworthy Educational Service, Buffalo, N. Y.

GENERAL SCIENCE WORKBOOK, by Gilbert H. Trafton, *Department of Biology, State Teachers College, Mankato, Minnesota*; Victor C. Smith, *Department of General Science, Ramsey Junior High School, Minneapolis, Minnesota*; and Edited by W. R. Teeters, *Supervisor of Physical and Biological Sciences, St. Louis Public Schools*. Revised. Paper. Pages vii+309. 19×25.5 cm. 1943. J. B. Lippincott Company. 333 West Lake Street, Chicago, Ill. Price \$1.00.

THE SQUANDER BUG'S CHRISTMAS CAROL, A 20-Minute Play for Elementary and Junior High Schools, Written as a Contribution to the War Finance Program by Aileen L. Fisher. Paper. 10 pages. 20.5×27 cm. Copies may be obtained from your State War Finance Office or from the Education Section, War Finance Division, U. S. Treasury Department, Washington 25, D. C.

WATSON-GLASER TESTS OF CRITICAL THINKING, by Goodwin Watson, Ph.D., and Edward Maynard Glaser, Ph.D. Paper. Battery I: Discrimination in Reasoning, Form A, 16 pages. Battery II: Logical Reasoning, Form A, 16 pages. 21.5×28 cm. 1942. World Book Company, Yonkers-on-Hudson, N. Y. Price per package of 25, net \$2.00.

## BOOK REVIEWS

TEXTBOOK OF QUANTITATIVE INORGANIC ANALYSIS, by I. M. Kolthoff, Ph.D., *Professor of Analytical Chemistry, University of Minnesota*, and E. B. Sandell, Ph.D., *Assistant Professor of Analytical Chemistry, University of Minnesota*. Revised Edition. Cloth. Pages xvii+794. 13.5×21.5 cm. 1943. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price \$4.50.

In the new edition of this text the subject matter and its organization is essentially the same as in the previous edition and in accordance with the original objectives of the authors—to prepare an outline of beginning

quantitative analysis of moderately comprehensive character in which there is a good balance of the practical and theoretical aspects of the subject.

Many teachers, who are in agreement that the topic of gravimetric methods logically precedes that of volumetric methods and believe that the advantages of presentation in this order outweigh those advanced for the reverse order, will be glad to see that this feature has been maintained in the new edition. The changes which have been made are mainly in the nature of keeping the book up to date and making it conform as far as possible to the needs of other teachers who have used the book.

Considerable new material has been added on the topic of the formation and contamination of precipitates, a field in which the authors have done much original work. The section upon organic precipitants has been slightly enlarged. A selected list of oxidation-reduction indicators covering a wide range of oxidation potentials has been included in a later portion of the book. The problems at the close of many of the chapters have been changed and in many instances the number available for use has been increased.

The present wide sale and use of various types of photo-electric colorimeters makes particularly appropriate the fuller treatment of spectrophotometric methods. Numerous analysts will encounter this subject later without having had contact with the equipment in formal class work. The same thing may be said of the amperometric methods of analysis. The section upon instrumental methods is necessarily brief but gives the student an insight into many specialized and advanced techniques.

For those who have not examined the earlier edition of the book, it may be said that the quantity and nature of the material is ideal for a year course in the subject. Many students who have had a very limited preparation in general chemistry and tend to be bewildered by the use of a text in which only selected topics are covered will not be able to appreciate the value of the book in a one semester course. Others, whose basic training has been good and whose interest in the subject is real, will find inspiration in the thorough presentation of principles and factors with which they are concerned in their laboratory program and upon which they can inform themselves beyond the ordinary requirements of a one semester course.

Teachers of brief courses will find the book an excellent source of supplementary information.

DUANE T. ENGLIS  
University of Illinois  
Urbana, Illinois

**A CHEMICAL-TECHNICAL DICTIONARY** (German-English-French-Russian), by A. W. Mayer. (Translation under direction of B. N. Menshutkin and M. A. Bloch.) First American Edition. Cloth. Pages i+870, 15×22 cm. 1942. Chemical Publishing Company, Inc., Brooklyn, New York. Price \$8.00.

The original publication in 1929 in the series of technical dictionaries by Mayer was a German word dictionary with each word followed by its counterpart in English and French. This new volume seems to be exactly like the first with the addition of the Russian equivalent carefully indicated. In compiling this technical dictionary, the author adheres to the German spelling of scientific terms, uses the formulae of organic compounds established by the German Chemical Society, adopts the German mineralogical names and alphabetizes as simply as possible. Umlauts remain as a single letter and ordinary prefixes are not transposed. Only Greek letter prefixes are ignored. A great number of synonymous entries

eliminate the need for cross references. This is very helpful to the reader, but it makes the volume larger and more costly. For example, calcium chloride and chlorcalcium are both listed. There are less than twenty abbreviations, all of which are quite obvious to the reader of the German language.

The author has this aim beyond that of the ordinary dictionary, to include a great many German phrases as well as words with their English, French and Russian equivalents. The emphasis is placed upon listing the vocabulary of the industrialist, the technical and trade expert and the dispensing chemist. The words are those used for manufacturing processes, apparatus, popular chemical terms, machinery and all types of professional phraseology. Since one finds no common German words included, this volume does not take the place of an ordinary dictionary. The author presupposes that his readers are familiar with everyday German.

For the American reader, this dictionary is excellent for reading technical German literature. However, the French and Russian equivalents may be found only if the German equivalent of the English word is already known. The reader, if he knew sufficient Russian grammar, might then be able to translate English into Russian, but not Russian into English which he is more likely to want to do. It is hoped that two new and more useful volumes may be published in America. One would be a revision of Volume 2 which is an English word dictionary with the French and German equivalent—to which the Russian equivalent might be added. The other would be a Russian word dictionary followed by the German, English and French counterparts. Since reviewers all praise the content and word selection of the earlier volumes, such a Russian dictionary would enable American research chemists to translate and interpret the reports from Soviet scientists.

VIRGINIA BARTOW  
University of Illinois

PRESERVICE COURSE IN AUTOMOTIVE MECHANICS, by James V. Frost, *Instructor in Automotive Trades, Brooklyn High School of Automotive Trades, Brooklyn, New York*. Cloth. Pages x+545. 14×21.2 cm. 1943. John Wiley & Sons, Inc., New York. Price \$1.96.

This book was prepared in conformance with the pre-induction course outline No. PIT202. Unlike so many hastily conceived books prepared for the war emergency, it shows evidence of leisurely planning, if not of actual construction. Undoubtedly the author had a wealth of material ready to use.

The greatest strength of the book is in its illustrations—a profusion of diagrams, sectional views, and phantom photographs. Unfortunately, not all have reproduced well, and many seem to have been copies without sharp focus. These do not detract greatly from the book's usefulness, but they do mar its appearance.

From the standpoint of a text, there is little doubt as to its value, providing classes have ready access to actual auto parts. This means that it should be used in practical shop courses. It is not at all adapted for use by those who have no experience with automobiles. One adverse criticism of the book is the tendency to depend too completely upon somewhat complex diagrams.

Various principles of physics are introduced when needed for explanation. For reasons of space, the treatment of the principles is superficial, needing additional explanation unless the pupils have had a previous course in elementary physics.

Physics and General Science teachers will find the book a valuable addi-

tion to their own bookshelves for quick reference to practical applications of physics. It is also recommended as a general reference for physics students who become interested in some phase of automobile operation.

WALTER A. THURBER

**AUTOMOTIVE MECHANICS**, in two volumes by Clarence G. Barger, *Instructor in Automotive Mechanics, Brooklyn High School of Automotive Trades, New York*. Cloth. Volume I, vii+166 pages. Volume II, viii+174 pages. 15.5 cm.  $\times$  23.5 cm. 1943. American Book Company, New York.

This well-bound, attractive series of two books is designed for a Course in Automotive Mechanics in accordance with the War Department Outline PIT202. Why the publishers choose to produce two small volumes instead of one moderate-sized volume is not apparent. Each volume is supposed to cover one semester's work.

The series is obviously a rush job, having an almost slavish agreement with the War Department outline. However, its discussions are lucid, and it is illustrated with excellent photographs and diagrams.

The content is Severely limited. Only fundamental structures are adequately treated; important accessories such as overdrives and power take-offs receive briefest mention. The physics requirement as given in the outline is met by suggesting, at proper intervals, that the instructor introduce certain demonstrations and experiments. Such brevity must limit the book's usefulness considerably.

Each section is appended by a series of questions. There is also a suggested list of visual aids at the end of the second volume.

This reviewer cannot help commenting on the startling cover design, which shows a madly careening tank rearing back on its "tail" and inanely firing all its guns skyward while two trucks plod prosaically alongside.

Besides its use in Automotive Mechanics courses, the book may also serve as a reference in general science and high school physics classes.

WALTER A. THURBER

**ELEMENTS OF FOOD BIOCHEMISTRY**, by William H. Peterson, Ph.D., *Professor of Biochemistry, University of Wisconsin, Madison, Wisconsin*; John T. Skinner, Ph.D., *Assistant Chemist, Kentucky Agricultural Experiment Station, Lexington, Kentucky*; and Frank M. Strong, Ph.D., *Associate Professor of Biochemistry, University of Wisconsin, Madison, Wisconsin*. Cloth. Pages xii+291. 14.5  $\times$  23 cm. 1943. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price \$3.00.

A list of chapter headings gives an idea of the content of the book. 1. Carbohydrates. 2. Fermentation. 3. Acidity. 4. Tepids (Fats and Related Substances). 5. Proteins. 6. The Mineral Elements in Nutrition. 7. Water. 8. Vitamins. 9 Enzymes.

The book contains thirty tables. The tables on Economic Importance of Some Industries Based on Carbohydrates, Comparison of pH Values, pH Values of Representative Standard Solutions, Economic Importance of Some Industries Based on Fats, Economic Importance of Some Industries Based on Proteins, Some Specific Organic Compounds of Mineral Elements Known to Exist in Plant and Animal Materials, Vitamin Content of Foods, Trace Elements in Foods, Percentage of Major Mineral Elements in the Edible Portion of Foods, and Vitamin Content of Common Foods, that should be of interest to teachers of high school chemistry and home economics.

Also the book contains thirty-four figures. Figures of starch granules from different sources, proteins from different sources, and several others

should be of great value to teachers of chemistry, biology, physiology, and home economics.

There is a list of review questions and references and suggested readings at the end of each chapter.

The authors emphasize the chemistry of the constituents of food and the chemical changes that these constituents undergo in the process of metabolism. Many important chemical compounds and changes have been expressed in formulas and equations.

The book is very interesting and is not difficult to understand.

E. G. M.

**THE CHEMICAL FORMULARY.** A Collection of Valuable, Timely, Practical Commercial Formulae and Recipes for Making Thousands of Products in Many Fields of Industry. Volume VI. Editor-in-Chief, H. Bennett. Cloth. Pages xx+636. 13.5×21.5 cm. 1943. The Chemical Publishing Company, Inc., 234 King Street, Brooklyn, N. Y. Price \$6.00.

The author states that "additional new formulae have been gathered to complete a sixth volume of the Chemical Formulary—an addition which will broaden and bring up-to-date the contents of volumes I, II, III, IV and V. Special elementary formulae of direct and indirect military interest have been included. A chapter on substitutes for scarce materials is an innovation which may be of interest and use to many."

A list of chapter headings gives an idea of the contents of the book. 1. Introduction. This chapter gives a general discussion on apparatus, heating, mixing and dissolving, filtering and clarification, decolorizing, pulverizing and grinding, weighing and measuring. Also there are many formulae for making cold cream, vanishing cream, hand lotions, brushless shaving creams, mouth washes, tooth powder, foot powder, chest rubs, and several other useful preparations. 2. Adhesive. 3. Beverages. 4. Cosmetics and Drugs. 5. Emulsions. 6. Farm and Garden Specialties. 7. Food Products. 8. Hides, Leather and Fur. 9. Inks and Marking Materials. 10. Lubricants. 11. Materials of Construction. 12. Metals, Alloys and Their Treatment. 13. Paint, Varnish, Lacquer, and Other Coatings. 14. Paper. 15. Photography. 16. Polishes and Abrasives. 17. Pyrotechnics and Explosives. 18. Rubber, Resins, Plastics and Waxes. 19. Soaps and Cleaners. 20. Textiles and Fibers. 21. Miscellaneous. 22. Substitute. There are tables of weights and measures: troy weight, apothecaries' weight, avoirdupois weight, dry measure, liquid measure, circular measure, long measure, square measure, metric equivalents of length, capacity, and weight. There is one table on the approximate pH values of acids, bases, foods and biological materials. There is a list of chemicals and supplies and where to buy them.

This is an excellent book for druggists, teachers of chemistry, industrial chemists, or for anyone who is interested in chemistry.

E. G. M.

**AIR NAVIGATION.** Flight Preparation Series. Published under the Supervision of the Training Division, Bureau of Aeronautics, U. S. Navy. Part One, Introduction to Earth. 29×21.5 cm. 79 pages, 8 chapters, 78 maps, charts and diagrams. \$1.00. Part Two, Introduction to Navigation. 81 pages, 5 chapters and many small maps, diagrams and figures. \$1.00. McGraw-Hill Book Company, New York, 1943.

The above two small volumes have been issued to aid high school and college instruction in air navigation. Such simple texts are needed to present clearly the fundamental elements suitable for basic training. A

high school senior of average ability ought to master the contents of each of these books in less than twenty hours.

Part One devoted to the earth makes a clear presentation of the strategic routes, supply lines, economic resources and some elementary strategy for each of the battle areas. Climate, weather, wind belts and ocean currents are all too briefly presented. The many diagrams are excellent but the introduction of comic drawings add but little to interest or understanding.

Part Two is a very simple introduction to navigation. The different types of map projections are well demonstrated as to their errors and use. Plotting of simple rhumb-line and map reading is clear and helpful. Many simple maps, plans and charts are included. The crude sketches, Figures 402 and 407, should be replaced with clear block diagrams.

VILLA B. SMITH

*RADIO—I, Written to Conform to the Pre-induction Training Course in Fundamentals of Radio as Prepared by the War Department*, by R. E. Williams, Manager, School Service, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pennsylvania, and Charles A. Scarlott, Editor, *Westinghouse Engineer*. Cloth. Pages x+132. 15.5×23.5 cm. 1943. American Book Company, 360 North Michigan Avenue, Chicago, Illinois.

*Radio—I* covers the first half of the year course outlined by the War Department of pre-induction training in the fundamentals of radio. A companion volume, *Radio—II*, completes the suggested course. The authors have carefully covered all of the material in the War Department outline but have subdivided it in a different fashion in one or two places.

The form of the book is good; charts and illustrations stand out clearly; standard, schematic symbols are used throughout. The line drawings are excellent and the half-tones timely. The material is clear, concise, and practical.

Each chapter has an adequate set of review questions and problems. In the appendix the authors present a table of radio and electrical units; a glossary of radio and electrical terms; a summary of the formulas found in the text and a series of laboratory exercises.

Considerable familiarity with mathematics and electricity is assumed although a review of electrical theory is presented in the third chapter. The student who has mastered the basic principles of electricity will find in this book an excellent presentation of the topic of radio. Much material that can ordinarily be found only in a series of texts is here organized into a comparatively few pages.

F. L. BURLINGAME  
Tuley High School, Chicago

*MINERALS, THEIR IDENTIFICATION, USES, AND HOW TO COLLECT THEM*, by Herbert S. Zim, and Elizabeth K. Cooper. Cloth. Pages vi+368. 13×20 cm. 1943. Harcourt, Brace and Company, Inc., 383 Madison Avenue, New York, N. Y. Price \$3.00.

This little book is for the amateur. If you are already a mineralogist or experienced collector, it is not for you. It tells the beginner what minerals are and how to collect them. It gives the easy tests for identification and tells how minerals were formed. Special chapters on some of the important metals, including copper, iron and aluminum, give important information on the processes used in refining them and also on the many various interesting minerals from which they are extracted. Two chapters are devoted to the interesting mineral quartz in its various forms and many

uses, and another chapter on gems gives many interesting facts about diamonds, rubies, the beryl gems, corundum, topaz and many others. Other important chapters tell how to identify rocks, their structure and formation; also a short chapter on the geology of the earth. The book is worthy of a place in any library and is an excellent gift book.

G. W. W.

**BASIC RADIO PRINCIPLES**, by Maurice Grayle Suffern, Captain, Signal Corps, Army of the United States. Cloth. Pages x + 271. 13.5 × 20.5 cm. 1943. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price \$2.25.

This is a textbook for students who previously have had a course in the elementary principles of electricity and are now ready for the fundamental facts of alternating currents and their applications to radio circuits. It will aid students in getting the fundamentals of radio, in acquiring knowledge of the materials used and their symbols, in the interpretation of fundamental diagrams, and in understanding the principles involved in the operation of radio equipment. The emphasis throughout is on the practical phases of how it works rather than on the theoretical aspects of why it operates as it does. The book is replete with good drawings and contains a minimum amount of quantitative work. A very practical and useful feature is the set of multiple-choice questions at the end of each chapter.

G. W. W.

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#### INDUSTRIAL SCIENCE AT WAR IS SHAPING A NEW POST-WAR WORLD

America's cultivation of science, which has proved the Nation's salvation in modern warfare, is destined to play an equally vital part in post-war reconstruction and employment, David Sarnoff, President of the Radio Corporation of America, said in an address before the Lancaster Chapter of the American Association for the Advancement of Science. He envisaged a new world of greater opportunities for industrial expansion and human welfare, being shaped by wartime developments in science.

"It is estimated that 10,000,000 jobs which did not exist in 1940 must be found to solve the post-war problem of employment," Mr. Sarnoff said. "One great hope in helping to meet this unprecedented challenge will be found in the fertile and unexplored frontiers of space. Science, offering new incentives, is beckoning capital to venture into the open skies."

Pointing out that millions of jobs have been created by coal, oil, and minerals underground, and by ships, railroads, automobiles, and industrial machines on the surface of the earth, Mr. Sarnoff said that the air is a new dimension offering new adventures and pioneering to a new generation. Now, he said, above the earth, aviation and radio, electronics and television can open the way for new opportunities in reemployment of war workers and for the millions of men and women who will return from service.

"The role of government in its relationship to labor and industry should be that of an umpire," Mr. Sarnoff said. "A wise government does not seek to favor either management or labor. It must be impartial, not partisan."

"When the war ends, and we enter the immediate period of transition, the government in fairness to both labor and industry must readjust its rigid wartime controls. The emergency regulations necessary in wartime,

but not necessary in peacetime, should be reduced as speedily as practicable. Elimination of wartime restrictions will enable manufacturers to produce and supply the goods needed by the Nation, to maintain employment, and to adapt new developments in industrial science for the benefit of all people."

Government should not unduly restrict private enterprise or enter into competition with industry, if American industrial science is to play its destined role in the reconstruction period after the war, Mr. Sarnoff said.

"On the other hand, it is of no avail for industry merely to point to the dangers of governmental restraints," he continued. "Industry must give evidence of leadership by presenting practical alternatives.

"The day of pioneering in America has not ended. Trail blazing now calls for joint effort by government, labor and industry. Their authority, experience and vision must fuse harmoniously to achieve success. There must be but one goal—the welfare of the people and the Nation.

"America must be practical. Science and industry must have American independence if they are to succeed in the gigantic task of reconversion, reemployment and world rehabilitation."

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#### THE CURMUDGEON SPEAKS ON EDUCATION

Aside from routine proclamations, etc., there have been few thought-provoking statements on education from important officials of the Administration in its 10 years of existence.

Last week Cabinet member Harold L. Ickes said some things on education worth citing. He wrote "strictly as a New Dealer."

"We have two things in this country in greater measure than they exist in any other country. These are education—a renewable resource of the mind—and virtually unlimited natural resources. A mixture of the two, shaken up and taken in proper doses when needed, has made the American and the America of today. For the sake of the future (another tenet of New Dealism) we must make a prudent use of our resources—developing but not wasting them, and at the same time not withholding them from use. . . .

"We have been regrettably negligent about seeing to it that our educational processes are pursued with that diligence which life in our own country and competition with other nations require if America is to maintain the position of leadership in many directions that it has already established. We have permitted 'the little red schoolhouse,' the symbol of universal education, to become a cliché. It is surprising how often we discover that what has been regarded as a fixture in our lives is no longer so. It both surprises and hurts to read the census figures on illiteracy in this land of 'universal' education. Actually, so far as 'universal' education, even of the common school variety, is concerned, we are not nearly so well advanced as we ought to be or as we have believed ourselves to be. Or, as a matter of fact, as we could be.

"Now I do not believe that every individual needs or ought to be educated to the same degree as everyone else. Essentially, we shall have provided universal education when we have made it possible for every individual to acquire learning up to the saturation point. It does not necessarily follow that we will have been universally, or even well, educated. But we will have done all that is possible to stamp out illiteracy when we will have enforced our truancy laws and put the individual in the way of an opportunity to get and use an education up to the limit of his ability to absorb it.

"This does not mean that we should be a nation of Ph.D.'s. It does not

even mean that everyone should have a college or even a high school education. It means exactly what it says, that, realizing that although all are not capable of acquiring or using the highest type of education, each is nevertheless entitled to have all that he is capable of mastering usefully. This would mean post-graduate degrees for some, professional and college courses for others, high school training for a still greater number, and grade school instruction in varying degrees for those who would be happier and more useful citizens if no attempt were made to push them beyond their capacity for 'book larnin'. In many cases, of course, intellectual development should be accompanied by, and even in some rare instances supplanted by, vocational training.

"As a nation, whether we are New Dealers in name or in fact, if we have a proper concern for our future and for the future of our country, we ought to insist that, if nothing else, we make education universally available to every one of our 135,000,000 people"

#### AFTER VICTORY, AS PREDICTED BY DAVID SARNOFF

"With victory will come the day when scientific instruments and processes of war will turn abruptly to peace," said Mr. Sarnoff. "Machines and tools, as well as industrial and economic thinking, will be converted quickly to the needs of peace. Industry will be called upon to relieve the strains of war with utmost speed by ministering anew to human welfare, health and comfort. Post-war planners are now at work in many fields of industrial endeavor."

Emphasizing the widespread applications of wartime developments of industrial science, Mr. Sarnoff listed new plastics, light metals, synthetic textiles, high-octane gasoline, artificial rubber, luminescent lighting, air-conditioning, dehydration of foodstuffs; also revolutionary advances in homes, aircraft, communications, ships, railroads, automobiles, highways, clothing and food.

Promising that the great modern art of radio will keep pace with the march of science and industry in every other field, Mr. Sarnoff stated:

"When this war ends, we shall be on the threshold of a new era in radio—an era in which man will see, as well as hear, distant events. . . . The day may come when every person will have his own little radio station tucked away in his pocket, to hear and to communicate with his home or his office as he walks or rides along the street.

"We have much to learn about the microwaves, in which is wrapped up this new world of individualized radio. Tiny electron tubes may make it possible to design radio receivers and transmitters no larger than a fountain pen, a cigarette case, a billfold, or a lady's powder-box. Some day people may carry television screens on their wrists as they now carry watches. As the useful spectrum of radio approaches the frontiers of light, the apparatus will become simpler and more compact.

"Radio vision will have many uses. It will serve wherever sight is needed. For instance, it will be used to prevent collisions on highways and railroads, on sea lanes and on the airways of the world. Radio will be the new eye of transportation and commerce. Applications of radio optics are unlimited."

Depicting science as a mighty ally of freedom, Mr. Sarnoff pointed out that scientific advances have brought much release from drudgery and from want. "However," he concluded, "we must progress still further. For better machines are not all that is needed to make a better life. We shall have a better world only to the extent that our social thinking and our social progress keep pace with the advance of physical science."